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The object of the present invention is to create a gas transporting and treating arrangement of the aforementioned kind having a plurality of electrodes of different geometries and mutual location, each of these electrodes is under electrical potential. The main features of this arrangement are, as follows:

- Ions' source. We should cover any of ions' sources in this item. The ions' source may be corona discharge arrangement which includes at least two electrodes having electric potential between them great enough to produce corona discharge. It may be a filament which being hot emits ions. It may be radioactive material, like Co 90, or so. It may be cell membrane, i.e., a plastic wall with tiny holes in it which are that small the strip atoms from electrons thus separating positive and negative charges and creating ions. It may be fluorescent lamp, or laser, or electret, or x-ray, or whatever.
- Source(s) of electric field(s) which attract, or repel, or direct, or in any other way applies force to the electrically charged particles and particulates.
- Source(s) of magnetic field(s) which apply forces to the charged particles on their move, i.e., when particles velocity is not equal zero.
- The electrodes which generate corona and create electrical field(s).
- The arrangement (constant magnet, coil, etc.) to create the magnetic field(s).
- Means for applying the electric potentials to the electrodes and maintaining (or in general controlling) these potentials on certain level to move and treat gas in desirable way.
- Means for electrical current generation which creates the magnetic field(s) or heat the filament or other electrodes.
- Means for separation the electrodes having different potentials to prevent electrical short (breakdown) between them.
- Means for directing airflow in certain way (ductwork).

See Fig. 2 for details.

All the above means and sources being implemented in different ways may enhance of operation of Electrostatic Wind Generator (EWG) and perform different functions to enhance EWG's range of applications. [The above arrangement is very close to what other people are doing in,say, vacuum tubes or ion propulsion devices [3].] We should, if possible cover ANY of the means of GENERATION and CONTROLLING ions and, therefore, gas movement. The purpose of claim 1 is to cover any possible improvement of existing air transportation devices of any matter. So far they are limited in:

- Ion source (only corona discharge is disclosed)
- Other electrodes variety

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Field of the Invention

The present invention relates generally to gas transportation devices and, in particular, to the devices that move air or other gases by electrostatic forces.

Background of the Invention

Description of the related art.

It is known that gas may be transported , in principle, with the aid of so called ion wind. In present art inventions the ion wind (or corona wind) is created when a corona electrode and a target electrode are mutually spaced apart and connected to the respectful terminals of a High Voltage Power Supply (HVPS) and when the geometry of the above electrodes are such as to give rise to a corona discharge at the corona electrode. This corona discharge, in turn, gives rise to air (gas) ions of the same polarity of the corona electrode and also to particles and particulates suspended in the air. The ions move rapidly under the influence and in the direction of electrical field. During their movement the air ions collide with the air molecules, thereby transfering electrostatic forces thereto, so that said air molecules are also drawn in a direction of electrical field, thereby effecting transportation of air in the form of a so-called ion, or corona, or electrostatic wind (see Fig. 1).

Earlier proposed air transporting devices based on the concept described above. Some of the inventions, for example, U.S. Patent #4,210,847, #4,231,766 consist of simple electrodes' arrangement, such as a needle and a cylinder surrounding the needle. Some comprise more sophisticated electrodes' arrangement, that include three electrodes (U.S. Patent #4,380,720). Two of the electrodes according to this invention generate corona discharge and produce so-called ion cloud. The third electrode in this invention is located downstream and serve for collection a dust and other particulates. Same invention uses a plurality of blowstages to increase a blower power or produce greater blower pressure differential.

Some of the inventions, like U.S. Patent #3,638,058 use alternating pulses to energize electrodes. By that means ions are under influence of attracting and repelling forces to accelerate their movement.

The common feature of all those devices is comparatively slow air (gas) velocity, uncontrolled ozone and NOx generation, low back pressure and non-uniform air flow.

Summary of the Invention

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- Voltages applied (only direct and pulse voltage are discussed). The magnetic field is used in ion propulsion engines, not in air movement devices.
- No invention uses MULTIPLE electrodes' arrangement, meaning a plurality of same kind, like a honeycomb.

Two main objectives should be considered as the primary ones for this invention. [First, ozone generation is an unseparable part of any existing EWG. While ozone is very useful in certain applications, like medical or food storing, people have some level of concern regarding ozone influence of their heath. Some people are ozone sensitive. Our objection is to control ozone generation and concentration on the desirable level.]

Second objection is to increase electrostatic wind back pressure. The existing EWGs create low back pressure which make them unaccepatble in most applications.

Among other objectives are, as follow:

- Change gas flow speed and direction (including reverse of gas flow) with the speed that much exceed a speed of conventional fans (make it inertialess).
- Change gas flow direction without moving parts.
- Block gas flow from one premises to another (like instant shutter).
- Enhance a draft of smock stocks.
- Enhance a performance of combustion process by dynamically controlling gas flow inside of a combustion chamber.
- Create lift force great enough to airbome flying apparatus and control it movement.
- Create and control negative and positive ions' flow and concentration.
- Collect dust and clean the gas from undesirable particles.
- Deodorize air.
- Desinfect air.

In order to better understand the way first two objectives are achieved one should consider the nature of ozone generation and the nature of a back pressure.

Ions which are emitted from corona electrode have comparatively low density. They hit just small portion of the air molecules. These ions have great average speed to transfer a sufficient amount of the energy to the air molecules. This speed is not uniform throughout of area of ion-molecules colliding. As it said before corona electrodes have sharp edges or are small in main size. In existing inventions corona electrodes are made of tungsten wire with typical diameter about 0.004" (0.1mm). The typical area occupied by one corona electrode's field is about 0.5" (10-12mm). If average ions' speed is, say, 1 unit/sec, the ions' speed in the vicinity of corona

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electrodes will be 0.5/0.004 = 125 times greater. Ions leaving corona electrodes' surface with that great speed collide with oxygen molecules and initiate a conversion O_2 air molecules to O_3 ozone molecules. It is well known from the experiments that lesser ions' speed means smaller ozone concentration. To decrease maximum speed of ions means to decrease ozone production and concentration. It is necessary, however, to maintain average speed of ions on the same level to keep air molecules speed the same. So, the objective is to make ions' speed throughout the volume of the device as uniform as possible to avoid excessive ions' speed anywhere. It seems obvious, that to decrease ions speed means to decrease electric field strength. It follows from the formula [1]:

$$V = (2e_0/D)^{1/2} E,$$

Where:
v = ions velocity
e = electrostatic permitivity of the gas
D = gas density
E = electric field strength.

It is also necessary to keep in mind that ions' density determines a back pressure magnitude. Small amount of ions can collide with corresponding small amount of air molecules. The greater ions density the more air molecules are affected and move. The greater moving molecules' density (the ration of moving to still molecules) the greater back pressure is. Maximum ions' density (in the vicinity of corona electrodes') is much greater that average ions' density. In the above example it is 125 times greater. Since corona electrodes must be much thinner it seems reasonable to move them closer to decrease the area each of them occupies. Unfortunately, thin wires being placed close to each other do not give rise to electrical field. So, corona electrodes should be separated by some reasonable space in order to provide better results. See Fig. 3 for details.

It is a good idea (U.S. Patent #4,380,720) to place a plurality of air (gas) accelerating stages in succession in order to further accelerate gas (air) so, that each following stage accelerates gas being earlier accelerated by previous stage(s). It should be understood that ions along with charged particles travel beyond the stages' area and are affected by the electrical field of next stage. To prevent any impact between stages no (or small) amount of charged particles (ions) must travel between the stages. They should be discharge or removed in the area between stages.

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So, global objective is to move corona electrodes closer to each other (and at the same time separate them electrically across downstream direction) and separate downstream stages electrically too. See figure 4 for detailes.

This objective is disclosed in claim #2.

Electrostatic Wind Generator (EWG)

1. An arrangement for air or gas movement without moving parts consists of number of electrodes (conductive and/or semiconductive, i.e., capable to conduct sufficient current), each electrode has an electric potential (induced or connected to the source of electric potential). Device comprises an ions' source which may be implemented as at least one pair of electrodes having high potential between them, one of these electrodes (corona electrode) has thin or sharp parts, on those sharp parts corona discharge occurs and ions are generated (emitted). General term for the corona electrode may be: "is provided with surfaces which gives rise to a powerful concentration of electric field". Positive or negative ions are emitted from ions' source (the corona electrode or, say, radioactive material) and move toward other electrode. On their move they are affected by the electric field from another electrodes. These electrodes have different electric potentials (some of them are connected to power supplies). Ions, being affected (attracted, directed or repelled) by these electrodes' electrical fields move with accordance with electrical field directions. On their way ions hit air or gas molecules forcing the last to move to the same direction. This way air or gas movement is generated. Other electrodes serve to repel or attract ions and perform (depending of their location, geometry, electrical potential and current through them) the following functions:

- attract ions (and other charged particles)
- repel ions
- neutralize (recombine) ions
- control ions' movement (accelerate, slow, focus, reverse, direct, block, stop, etc.)
- attract dust particulates and collect them
- create magnetic field (that needs a coils or constant magnet)
- heat air.

2. Arrangement for air or gas movement, having multiple electrode's array(s) comprises multiple electrodes of the same kind substrates having high potentials between them, each conducting part of those substrate is separated from conducting part of other substrate having different electric potential by insulation (air) gap and non-conductive surface. This surface is long enough to ensure a safe distance to withstand a creeping

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discharge. As a one of implementation the number of those electrodes are located on separate insulating substrates, those substrates's non-conductive surfaces have points of mutual contacts in the areas remote from the conductive surfaces. This is to make "creeping discharge path" as long as possible. The good point for this claim description is, as follows: *the ratio between the surface length Ls separating electrodes, having different potentials, to the air (gas) gap length Lg, separating the same electrodes, must be greater than or equal to the ratio between creeping discharge to the gap discharges' breakdown voltages under any operation conditions.*
The essence of this claim is in the word "multiple". Unlike of others we use many electrodes of the same kind to separate corona electrodes across downstream direction. They are located at the same substrate(s). These substrates are separated by a) air gap and b) surface. See Fig. 5 for details.

3. A plurality of corona electrodes as claimed in claim 2, are separated from each other by the plurality of so called exciting electrodes, said corona discharge occurs in areas between corona and exiting electrodes and doe to the electric potential difference between of the two. See Fig. 6, 7, 8 and 9 for detailes.

4. The arrangement for air or gas movement comprises of the stages located in succession of air movement, at least one of these stages has the electrode(s) for charged particles' recombination (discharging) so that these electrode(s) are located downstream of this stage ions' source and have an electrical potential attracting the ions being generated by this corona electrode and charged particles (particulates). See Fig. 10 for details.

5. The arrangement for air (gas) movement having a duct within with said electrodes enclosed, each group of electrodes is connected to the source of electrical potential (generated or induced) said duct has a chamber for at least part of the High Voltage Power Supply placement, for, example, said HVPS has low voltage and high voltage parts, where low voltage part is located outside the duct while high voltage part is located within this duct.
Note: In existing inventions there is a problem to put HV into the ductwork where the electrodes are located. HV connectors are expensive and HV outside of the ductwork is dangerous. If more than one voltage is needed more expensive HV connectors are. Claim 5 erases this concern. Since all the voltages are generated in the vicinity of electrodes there is no need to use HV connectors or HV cables. The only outstanding cable is the low voltage one which goes to electrical outlet. In case of battery powered device even this cable does not exist.

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6. The arrangement as claimed in claim 5, where alternating current is applied between the electrodes (or group of electrodes), those electrodes are connected to each other and other electrical components so the capacitances between said electrodes' are placed in electrical circuit as a part of the last and take part in electrical potential generation.
Note: the real intention of this claim is to use a natural capacitance between the electrodes as part of voltage multiplier. This will save space and decrease price. See Figure 11 for detailes.

7. The arrangement as claimed in claim 5, where some of the electrodes are used as the diodes, i.e., conducting electrical (corona) current in one direction and not conducting in another under the preset conditions.
Note: this claim has the same intention as the claim 6. The feasibility for this claim derives from the fact that positive and negative corona onset voltages have different magnitude. Say, in [2] Fig. 3 and 4 show the corona onset voltage for positive polarity is 10.5 kV while for the negative polarity (same electrodes) - 15 kV. If applied AC voltage is in between of those magnitudes it means that this group of electrodes may conduct electrical current in one direction no conducting it in another direction, i.e., act as diodes do..

8. The arrangement as claimed in claim 1, which includes sources of magnetic field(s) those fields force moving charged particles to move in desirable direction. As an example the arrangement may be made in the shape of the cylindrical tube with particles moving along this tube and magnetic field is produced by the coil embracing this tube, the magnetic field applies the forces which are rectangular to the initial gas movement and forces the ions to move in spiral direction thus further accelerating them to increase gas velocity.
Note: one of the interesting possibilities is to increase ions and gas velocity in spiral direction then release accelerated gas in this direction. See Figure 12 for detail.

9. The arrangement as claimed in claim 2, which includes several electrode arrays, each is capable to move gas, those arrays are located in the manner allowing to move gas in circular direction thus accelerating gas, the arrangement has an outlet and an inlet, the inlet is located in the cross direction to the principal gas movement, the outlet is loced downstream of the principal gas movement direction. See Fig. 13 for detail.

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10. The arrangement as claimed in claim 4, where each group of electrodes located in succession has different electrical potential between corona and accelerating electrodes, preferably, but not limited to, each following (downstream) group having greater electrical difference between the same electrodes than previous group.
11. The arrangement as claimed in claim 1, where at least one of the electrodes or group of electrodes is made of a conductive material having comparatively high specific electrical resistance. Tungsten may be used as a good example. Also, these electrodes may be heated by an additional low voltage power supply to produce heat. The warm air is moved from the first to the second group of electrodes and further to the output space. The heat amount may be controlled by a temperature sensor and a controlled low voltage power supply. It may maintain a constant or controlled temperature where desired.

12. The arrangement as claimed in claim 1, comprises the sensors which measure the air velocity, the air volume per time, dust density, humidity, temperature, etc. and control the output voltage of HVPS and a low voltage power supplies in order to achieve the desired applications goals.

13. The arrangement as claimed in claim 5, where at least part of electronic components which produce a heat, such as its power transistors, diodes, transformers, heat sinks, etc. are located in the area of the moving air to cool them down.

14. The arrangement as claimed in claim 1, which comprises at least two group of electrodes' arrays, each group capable to move gas, each has different principal directions of gas movement. Those devices are preferably connected to different HVPSs those HVPSs are capable to generate controlled voltages on the electrodes of different groups thus moving gas with different directions (say to reverse gas flow) when gas velocity of these groups are controlled by those voltages. This is an arrangement for gas moving in different directions (like oscillating fan) without

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moving parts. If three or more arrays are used the gas movement may be changed in three dimensions.

15. The HVPS for the arrangement as claimed in claim 1, which produces an output HV with "flexible top". Since it is not convenient term some explanation is necessary. Corona discharge works within a rather narrow voltage corridor. The lower boundary of this corridor starts at corona onset voltage and the high boundary is just below the level where breakdown (sparks) starts. If voltage across the array is below the corona level the current through the array is of small magnitude. It is a so called "leakage current". When voltage increases, corona discharge begins and current grows. Above the corona level current grows much steeper than voltage. Since the air condition is not usually stable, the breakdown level may vary. This level is preceded by the corona current increasing. The ideal HVPS must foresee this level and maintain the voltage across the array at a safe level. This may be done by having a self-adjusting HVPS, which samples or measures the output current level and increases or decreases the voltage to the level corresponding to the current's level. The proposed HVPS design generates the output high voltage with "flexible top curve". This term means a HVPS with a more stable "base voltage" and a "flexible top voltage". The output voltage is the sum of these two voltages. The U1 is a "base voltage" and U2 is a flexible one. The common output voltage Uout = U1 + U2. While the "base voltage" is close to the corona onset level, the maximum sum of this and a "flexible top voltage" level exceeds the spark level. This maximum "flexible top voltage" is generated when output current is of minimum value. When output voltage is close to the spark level for certain conditions the corona current grows and the output voltage drops within the "flexible top voltage" value. So does the sum of the two voltages. Having been properly designed the HVPS generates the output voltage at a level that guarantees the pre-breakdown condition of the electrodes' array. The "flexible top" HVPS may be made in a variety of ways. One is shown in Fig. 14. The HVPS consists of two HVPSs (HVPS 1 and HVPS 2) connected in series. The HVPS 1 generates a "base voltage". The HVPS 1 has a slight or no dependence on output voltage from output current. In other words HVPS 1 generates stable output

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voltage. This voltage's magnitude is big enough to onset a corona discharge. The HVPS 2 generates output voltage that depends on output current. The maximum voltage occurs at the output when no current flows to the corona electrodes. In no-load condition the common voltage of HVPS 1 and HVPS 2 exceeds breakdown voltage of the array. When output current increases the output voltage drops. The simplest implementation of this idea may be achieved by using a step-up transformer for the HVPS 2 with large leakage inductance. The output current flows through the leakage inductance and creates a voltage drop across it. The more current applied, the more voltage drops across the inductance. The more voltage drops across the inductance the less output voltage at the output of HVPS 2. This HVPS generates the output voltage with "flexible top". It will be appreciated that a "flexible top" HVPS will be considered as a combination of "flexible" and "stable" HVPSs connected in series without departure from the spirit of the invention. This means that the HVPS may consist of any number of "stable" and "flexible" HVPSs connected in arbitrary order. Another "flexible top" HVPS implementation may be achieved by using a voltage multiplier with different capacitors' value. See Fig. 15. The capacitors C1 - CN are of a greater value, than the capacitors CN+1 - CM. The voltage drops at the voltage multiplier output is directly proportional to the output current and reversely proportional to the capacitors' value. For such voltage multiplier the voltage drop is of a much lesser value through capacitors C1 - CN than the voltage drops through capacitors CN+1 to CM, which is of a much greater value. The voltage U1 may be considered as a "stable" voltage, while the voltage U2 as a "flexible top" voltage. It will be appreciated if the margin of Umin and Umax may be of any value that guarantees the working requirements for the array and will not be limited by corona and breakdown levels.

16. Another EWG improvement may be made if electrodes have a bent shape as is shown in Fig. 16. This shape allows moving the air in a certain direction with or without side lobes. The array may be concaved up or down. In the first case it will dissipate the air moving from the array. In the second case the moving air is concentrated or aimed towards its desired point.

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17. Being installed within a ductwork or ductwork's net (web) the arrays or parts of the arrays may be removable and replaceable from time to time. This must be done when the array is excessively contaminated or damaged. It will be appreciated if the ductwork has a slot (or other means) for an array installation. The array may consist of one or more frames supporting electrodes. To remove an array means to pull it out. To install it means to put it back or replace it. See Fig. 17.

18. Still another improvement may be achieved when the HVPS is programmable to produce high voltage changes in the course of time. This feature creates several new effects. First of all, the air velocity and volume per time becomes different. This makes EWG able to produce a desirable amount of air movement according to a preset program or outside condition. If, for example, more pollution passes through the EWG, greater voltage may be needed to clean the air. Another example is that by changing voltage, "low" and "high" settings of air volume may be achieved, comparable to conventional fans. Also temperature changes may require more cooling ability and, therefore, a greater voltage. A HVPS may change the output voltage in accordance with a preset program, or in accordance with an environmental condition, or to adjust airflow volume.

19. An arrangement as claimed in claim 14, where HVPSs may produce different high voltages over time. The resulting air direction and velocity will vary. This creates a new effect of the air blowing in different (constantly varying over time) directions without any moving parts.

20. Still another implementation (and application) may be made using EWG as a "heat sink". The arrays are installed between a heat source and a place where heat is wished to be suppressed. A furnace on one side and laboratory equipment on the other side provide an example of this application. The arrays are located between these two places forcing the air to flow orthogonal to the line between the heat source and the

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location wished to be kept cool. (It may be any other angle as well). At the extension of the air direction a heat sink is located. It may be a heat sink or, say ,a hole in a ceiling, or other means for exhausting air which is desired to be kept separated. . The EWG "heat sink" may be used in different applications where a transparent (or a low cost) barrier is needed. It may be used for office, industry, electronic devices or technological applications as well. See Fig. 18 for the details.

21. Another EWG implementation is a flying apparatus. A light weight EWG with some of the electrodes located horizontally creates a lifting force that may cause it to fly (or hover). The horizontal (or close to horizontal) electrodes create a lifting vertical force, as it is shown in Fig. 19. Other wind directions that are created by EWG may be used for horizontal movement and maneuvers. Light weight electrodes are made from light weight (or hollow) material with a conductive surface. The HVPSs are connected to the arrays. The HVPSs may or may not fly with the arrays. If not, the HVPSs are connected to the arrays through light weight wires. It is preferable that the wires carrying different voltages are located apart from each other. Since EWG needs only low current (measured in milliAmperes) to generate air movement these wires must be of a small diameter and be light weight. The arrays themselves may be made of light weight hollow balloons. They may be made of plastic material, say, used for hot air balloons, covered with a thin conductive film. They may be filled with light weight gas like helium. Having light weight these devices need a small force to lift them up. In this way one is able to create a flying apparatus which is noiseless, and fully controlled in all directions. One more advantage of this apparatus is that it has much less inertia in comparison the hot air balloons and it is simpler than other hovercraft.

22. The flying apparatus described above may be used together with heating and cleaning features. Being fully controlled and able to fly in any direction this apparatus may be used for cleaning or heating (or other needs) of inaccessible areas, say, pipes or other enclosed or hazardous areas. Another implementation may be seen for the hermetically sealed areas which need to be constantly cleaned. Being located inside of such area and powered from HVPSs, the flying air conditioner (which means cleaning,

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heating and either abilities described above) may be directed to the desirable objects and remove (or, more accurately, collect) dust or other contamination from these objects. It may also heat desired objects or treat them within the ability of EWG described above. After the technological process is accomplished the area is opened and EWG with collected dust may be removed and cleaned or it may be returned for continuation of the process.

23. The flying EWG may be used for explosive gases control. It is a well-known problem in the mining industry, where undesirable methanol concentration lead to the devastating explosion. For safety reasons it is desirable to ignite these concentrations prior to the time when they will exceed a safe level. Some of these areas are inaccessible and this prevents an effective explosive gases control. The EWG combines the ability to fly with the ability to create sparks between its electrodes. The spark frequency (or presence) may be controlled by the high voltage magnitude that is applied between the electrodes. The flying EWG may be directed to an inaccessible area. After it reaches this area the HVPS increases the high voltage magnitude between the electrodes creating one or more sparks between the electrodes. The sparks thus ignite the explosive gases and reduce their concentration.

24. Being inertialess by nature EWG is capable to produce a pulse in the air movement (gusts). One of the pulse EWG applications may be a wind tunnel. Wind tunnel tests for aircraft stipulate that along with a steady air flow, a pulse (or quickly changed) air movements are needed as well. These quick air movements may be useful for simulating real atmosphere conditions. Conventional blowers by design have inertial limits which make them unable to produce the sharp, quick change in air movement desired. The pulse EWG may be used for such a test (simulation or modeling).

25. The array with the different distance between the electrodes is shown in Fig. 20. The aim of the different air gaps is to direct the air in the desired direction. The closer

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the rods of the array are, the stronger the wind is in this area. The array with arbitrary gaps may direct the air flow as a result of all the flows produced by the array's parts. The array shown in Fig. 20a generates more wind by the ends than by the middle parts of the array. Being designed this way the array blows the wind as a directional aerial. The "side lobes" may be suppressed or amplified. The same array may be made with the middle parts closer to each other than side parts. That array will generate a wind with more of a rounded shape (See Fig. 20b).

26. The ultimate EWG systems are comprised of a number of arrays (or wind generators) together with other heating, cleaning (described above) devices, sensors and improvements. This system has one or more HVPS and also low voltage power supplies, connected to the electrodes of the number of arrays. The control system monitors and changes the high voltage at the each electrode to maintain the necessary air velocity, heat, cleaning ability, etc. that is desired. This EWG system may be part of, say, a buildings air conditioning system.

27. For most applications the sharp and dull edges of the different rows of electrodes must be located at the same distance from each other. This requires a lot of precise work and labor. To facilitate this requirement the array comprise flexible, but sharp, edges. These edges, which serve as the corona emitting parts, (or corona electrodes themselves, or parts of corona electrodes) are flexible and/or movable. They are able to move (float, bend, etc.) to their desired location, geometry, and shape, once wind and electrostatic forces are introduced. The aim is to allow the sharp edges to arrange themselves into uniform (electrostatic wise) mutual shape. All of the sharp edges will maintain an equal distance from the opposing dull rods. It may be seen as an array of hollow tubes (flexible or rigid) with threads (fringe) located on one side. These tubes and edges (fringe) are made of conductive material. Another implementation of this idea are flexible electrodes (Fig. 21). If some part of the electrode produces more strong wind than another, it will repel from the opposite electrodes and increases the distance (the gap) between these electrodes.

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28. Being inertialess EWG may generate not just air movement but also sound. The EWG produces a sound when high voltage, applied to the array, changes the magnitude of the frequency within the sound range. The EWG shown in Fig. 22 has a sound sensor (mike) and HVPS that changes its output voltage in accordance to the incoming sound (going in the EWG direction). The air movement that is produced by the EWG is flowing in the opposite direction (it meets the incoming sound). The wind, produced by EWG, is of the same intensity (velocity) as the incoming sound and eliminates (or, at least reduces) this sound. The sound barrier, based on the principle described above, consists of a number of arrays and a number of HVPSs. Each HVPS is equipped with a sound sensor (microphone) and a control system that changes the output voltage of each HVPS. The HVPSs that are connected to the velocity control electrodes are of an inertialess type. The HVPS produces just enough high voltage to control air movement of opposing direction to that of the sound entering to the array. This implementation eliminates (or, at least, reduces) all of the sound going to the number of arrays. This may be called "a clear sound barrier". It is interesting that this "sound Barrier" may be "unipolar", i.e.,one way, other words, be clear to the incoming sounds and to block outgoing sounds.

Should you have any questions feel free to contact me at any time as at the letterhead.

Igor A. Krichtafovitch

Igor A Krichtafovitch

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Summary of the Invention

(claims)

1. The electrostatic wind generator (hereinafter EWG) is disclosed having at least two group of electrodes (i.e., the first group and the second group) both groups being fed by a high voltage power supply (hereinafter HVPS). These two groups form the electrodes' array. The high voltage being applied to the electrodes is big enough to emit positive or negative ions from the first group of above mentioned electrodes. These ions are attracted by the second group of electrodes which has an opposite polarity. The ions are accelerated by the voltage difference between the groups of electrodes. The ions move from the first group of electrodes, they are emitted from, toward the second group of electrodes having opposite polarity and father. The ions being moved meet the air molecules as well as particulates floating in the air. The ions hit the molecules and particulates forcing them to move in the same direction. In this way electrostatic air movement (or wind) is produced.

The first group of electrodes are designed to facilitate the ions' or electrons' emission from the electrodes' surface. In order to do so, the first group of electrodes are provided with sharp edges, or are thin in their main size. As an example, they may be made of thin wire. As another example, they may be made of barbed wire. They may be made of knife blades, etc. There is a variety of ways to make this surface "sharp". These "sharp" edges must be directed toward (or located close) to the second group of electrodes. It is well known that the electrical field is much greater along sharp edges or surfaces (like at a needle's point).

The second group of electrodes, on the contrary, do not have any kind of "sharp" angles directed toward, or located close to the first group of electrodes. This feature prevents ions from being emitted from the smooth (or round) second group of electrodes' back to the first set of electrodes.

The high voltage electricity is produced by HVPS. HVPS produces high voltage. There are different ways to produce HV. One of them is to step up the primary alternating voltage by the transformer and then further raise the voltage by voltage multiplier. As the electrodes' array efficiency is greater when it works close to the breakdown level, the HVPS must be capable to quench sparks or arks that may occur in the area located between the electrodes. To do so, HVPS's output current must be limited. Another possibility is to provide HVPS with a control system capable to react quickly enough to "quench" sparks and/or decrease output voltage. HVPS provides by its mean (or is designed so) the maximum output current of the

electrodes is safe for human interaction and will not cause electrocution if touched. See Fig. 1 for details.

Additionally, a number of different improvements of this initial idea may be presented.

2. First, the arrays' cross area may be made in any desirable shape (say, the shape of ductwork). See Fig. 2.

3. Another improvement that may be beneficial is to locate the first group of electrodes in between, not directly across from the second group of electrodes. This geometry helps the air to move more freely by not being obstructed by the second group of electrodes. It is more specifically described in Fig. 3.

4. To increase the air velocity, several arrays may be located in series one after another in the principal direction of the air movement. It is preferable, but not limited by, that each of the arrays has it own HVPS to adjust the voltage to the array's geometry and environment. See Fig. 4

5. To ionize the air, the same types of electrodes of the different arrays may be fed by the same high voltage polarity (Fig. 5).

6. To decrease the number of particulates or molecules being charged, the electrodes of the different arrays may be fed by opposite polarity. To decrease charge to the minimum possible level the number of arrays may be even, half of them being fed by positive polarity while the other half of the arrays are being fed by negative voltage. In another implementation, part of the arrays may produce the same (or controlled) amount of positive and negative ions in order to produce a controlled (zero, for example) amount of ions at the output of the EWG. See Fig. 6.

7. The second group of the electrodes may be made in a elongated shape. The air and particulates traveling along this surface will be accelerated by the electrodes' array (or arrays). The particulates are charged by the ions emitted from the first group of electrodes. Since the second group of electrodes is under the opposite voltage (potential) the particulates are attracted to the second group of electrodes and stick to the electrodes' surface. Thus the air is cleaned and leaves the array with less particulate than it had upon entering the array. See Fig. 7.

8. Further improvement may be made if one of the electrodes or group of electrodes is made of a conductive material having comparatively high specific electrical resistance. Tungsten may be used as a good example. Also, these electrodes may be heated by an additional low voltage power supply to produce heat. The warm air is moved from the first to the second group of electrodes and further to the output space. The heat amount may be controlled by a temperature sensor and a

controlled low voltage power supply. It may maintain a constant or controlled temperature where desired. Fig. 8.

9. Another improvement may be made by developing an insulating surface which divides the first and second groups of electrodes. This surface must have enough distance to prevent creeping discharge. Fig. 9.

10. Still further an improvement is that the electrostatic wind generator may be supplied with different kinds of sensors. These sensors may measure the air velocity, the air volume per time, dust density, humidity, temperature, etc. and control the output voltage of HVPS and a low voltage power supplies in order to achieve the desired applications goals. Fig. 10.

11. Since the electrostatic wind generator produces a certain amount of air movement, it will be productive to install the electron devices (components) of HVPS, which produce a heat, such as its power transistors, diodes, transformers, etc. in the area of the moving air. This will cool the electronic components and protect them from overheating. The EWG air velocity is approximately proportional to the power produced by the HVPS. When more power is generated, more heat will be produced by the electronic components. When more heat is produced, the components have more need to be cooled. The more they need to be cooled, the more the EWG air velocity. The more the air velocity the more the air cooling ability. In this way HVPS produces the air that is proportional to its need to be cooled. Fig. 11.

12. Further improvement may be made by dividing the first (or the second) group of electrodes into two subgroups. Each of these subgroups is located on both sides of the other group (i.e., second, if the first is divided and vise versa). The HVPS is connected to all of the groups and subgroups. HVPS is capable of applying the high voltage to one or the other subgroup (with respect to both groups of electrodes). When one of the subgroups is fed, the air is forced to move in one direction. When the other subgroup is fed, the air is forced to move in the opposite direction. This way the electron wind generator may produce air flow in different directions. See Fig. 12.

13. The bi-directional array may be used to control air movement produced by an outside source. If outside air movement enters the array, the array's forces may add or subtract to this air velocity. An air movement sensor measuring the air movement may adjust the output voltage to the HVPS and produce desired EWG wind. This may be used to induce or invert, for example, chimney draft. It may be used to block the air movement from one premise to

another. It may be useful to prevent contaminated air from penetrating another area. This we shall call "the air barrier". It may be useful in some applications to prevent fast air movement from penetrating "the air barrier". To do this an array must generate quick counteracting wind. See Fig. 13. The EWG may be used as the gas barrier between two spaces. Being fed by the inertialess HVPS (or HVPSs) and being inertialess by nature, EWG may prevent any gas movement through the array. The bi-directional array may do this in both directions, while a one-directional may prevent the air movement in just one direction. To prevent (or stop) the gas movement the EWG is provided with a gas movement sensor (or sensors) and a feedback device. The sensors sample gas movement and causes the HVPSs to change output high voltage across the arrays. The HVPSs change output voltages so that the arrays create a meeting (counteraction) of gas flow (forces) of the same power. The resulting force must be of negligible value so that no gas movement occurs through the arrays. This results in a gas barrier that neither allows gas movement nor heat transfer through the arrays. In this way it is possible to create a clear (transparent) gas (and heat) barrier. It may be called "a clear wall".

14. Another set of improvements may be achieved by the combination of HVPS design with electrostatic wind generator (EWG). A background for understanding this is as follows. EWG works within a rather narrow voltage corridor. The lower boundary of this corridor starts when corona discharge begins and the high boundary is just below the level where breakdown (sparks) starts. If voltage across the array is below the corona level the current through the array is of small magnitude. It is a so called "leakage current". When voltage increases, corona discharge begins and current grows. Above the corona level current grows much steeper than voltage. Fig. 14 shows experimental current versus voltage curve for the array shown in Fig. 1. Since the air condition is not usually stable, the breakdown level may vary. This level is preceded by the corona current increasing. The ideal HVPS must foresee this level and maintain the voltage across the array at a safe level. This may be done by having a self-adjusting HVPS, which samples or measures the output current level and increases or decreases the voltage to the level corresponding to the current's level. This is the first combination of a HVPS with the EWG.

15. The second combination may be made by employing HVPS with drooping current versus a voltage characteristic curve. An example of such a

electrodes is safe for human interaction and will not cause electrocution if touched. See Fig. 1 for details.

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11. Since the electrostatic wind generator produces a certain amount of air movement, it will be productive to install the electron devices (components) of HVPS, which produce a heat, such as its power transistors, diodes, transformers, etc. in the area of the moving air. This will cool the electronic components and protect them from overheating. The EWG air velocity is approximately proportional to the power produced by the HVPS. When more power is generated, more heat will be produced by the electronic components. When more heat is produced, the components have more need to be cooled. The more they need to be cooled, the more the EWG air velocity. The more the air velocity the more the air cooling ability. In this way HVPS produces the air that is proportional to its need to be cooled. Fig. 11. For Meris

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13. The bi-directional array may be used to control air movement produced by an outside source. If outside air movement enters the array, the array's forces may add or subtract to this air velocity. An air movement sensor measuring the air movement may adjust the output voltage to the HVPS and produce desired EWG wind. This may be used to induce or invert, for example, chimney draft. It may be used to block the air movement from one premise to

another. It may be useful to prevent contaminated air from penetrating another area. This we shall call "the air barrier". It may be useful in some applications to prevent fast air movement from penetrating "the air barrier". To do this an array must generate quick counteracting wind. See Fig. 13. The EWG may be used as the gas barrier between two spaces. Being fed by the inertialess HVPS (or HVPSs) and being inertialess by nature, EWG may prevent any gas movement through the array. The bi-directional array may do this in both directions, while a one-directional may prevent the air movement in just one direction. To prevent (or stop) the gas movement the EWG is provided with a gas movement sensor (or sensors) and a feedback device. The sensors sample gas movement and causes the HVPSs to change output high voltage across the arrays. The HVPSs change output voltages so that the arrays create a meeting (counteraction) of gas flow (forces) of the same power. The resulting force must be of negligible value so that no gas movement occurs through the arrays. This results in a gas barrier that neither allows gas movement nor heat transfer through the arrays. In this way it is possible to create a clear (transparent) gas (and heat) barrier. It may be called "a clear wall".

14. Another set of improvements may be achieved by the combination of HVPS design with electrostatic wind generator (EWG). A background for understanding this is as follows. EWG works within a rather narrow voltage corridor. The lower boundary of this corridor starts when corona discharge begins and the high boundary is just below the level where breakdown (sparks) starts. If voltage across the array is below the corona level the current through the array is of small magnitude. It is a so called "leakage current". When voltage increases, corona discharge begins and current grows. Above the corona level current grows much steeper than voltage. Fig. 14 shows experimental current versus voltage curve for the array shown in Fig. 1. Since the air condition is not usually stable, the breakdown level may vary. This level is preceded by the corona current increasing. The ideal HVPS must foresee this level and maintain the voltage across the array at a safe level. This may be done by having a self-adjusting HVPS, which samples or measures the output current level and increases or decreases the voltage to the level corresponding to the current's level. This is the first combination of a HVPS with the EWG.

15. The second combination may be made by employing HVPS with drooping current versus a voltage characteristic curve. An example of such a

curve is shown in Fig. 15. The third combination may be made by a special HVPS with "flexible top curve". This term needs explanation. Let us understand that "flexible top" HVPS means a HVPS with a more stable "base voltage" and a "flexible top voltage". The output voltage is the sum of these two voltages. This "flexible top" HVPS has a characteristic curve like is shown in Fig. 16. The U1 is a "base voltage" and U2 is a flexible one. The common output voltage Uout = U1 + U2. While the "base voltage" is close to the low corona level, the maximum sum of this and a "flexible top voltage" level exceeds the spark level. This maximum "flexible top voltage" is generated when output current is close to a minimum level. When output voltage is close to the spark level for certain conditions the output current becomes of greater magnitude. In response to current increase the output voltage drops. So does the sum of the two voltages. Having been properly designed the HVPS generates the output voltage at a level that guarantees the pre-breakdown condition of the electrodes' array. The "flexible top" HVPS may be made in a variety of ways. One is shown in Fig. 17. The HVPS consists of two HVPSs (HVPS 1 and HVPS 2) connected in series. The HVPS 1 generates a "base voltage". The HVPS 1 has a slight or no dependence on output voltage from output current. In other words HVPS 1 generates stable output voltage. This voltage's magnitude is big enough to initiate a corona discharge of small intensity. The HVPS 2 generates output voltage that depends on output current. The maximum voltage occurs at the output when no current flows to the load (array). In no-load condition the common voltage of HVPS 1 and HVPS 2 exceeds breakdown voltage of the array. When output current increases the output voltage drops. The simplest implementation of this idea may be achieved by using a step-up transformer for the HVPS 2 with large leakage inductance. The output current flows through the leakage inductance and creates a voltage drop across it. The more current applied, the more voltage drops across the inductance. The more voltage drops across the inductance the less output voltage at the output of HVPS 2. This HVPS generates the output voltage which is dependent on output current.

16. It will be appreciated that a "flexible top" HVPS will be considered as a combination of "flexible" and "stable" HVPSs connected in series without departure from the spirit of the invention. This means that the HVPS may consist of any number of "stable" and "flexible" HVPSs connected in arbitrary order. See example in Fig. 18.

17. Another "flexible top" HVPS implementation may be achieved by using a voltage multiplier with different capacitors' value. The HVPS is shown in Fig. 19. The capacitors C1 - CN are of a greater value, than the capacitors CN+1 - CM. The voltage drops at the voltage multiplier output is directly proportional to the output current and reversely proportional to the capacitors' value. As for the HVPS shown in Fig. 19, the voltage drop is of a much lesser value through capacitors C1 - CN than the voltage drops through capacitors CN+1 to CM, which is of a much greater value. The voltage U1 may be considered as a "stable" voltage, while the voltage U2 as a "flexible top" voltage.

18. It will be appreciated if the margin of Umin and Umax may be of any value that guarantees the working requirements for the array and will not be limited by corona and breakdown levels.

19. It will be also appreciated that under "flexible top HVPS" any HVPS configuration which performs as described above and within the spirit of this invention will be recognized.

20. Another EWG improvement may be made if electrodes have a bent shape as is shown in Fig. 20. This shape allows moving the air in a certain direction with or without side lobes. The array may be concaved up or down. In the first case it will dissipate the air moving from the array. In the second case the moving air is concentrated or aimed towards its desired point.

21. The array carries high voltage between the groups of electrodes. This means that one of the groups may be under a desired voltage with respect to "ground" or to other nearby objects. One of the objects to be considered may be a ductwork's walls. These walls are usually under "ground" potential. A further improvement of the EWG is an additional insulation between the electrodes under high voltage and outside objects. It may be any kind of insulator, including gas insulation. The preferable way of insulation is a solid barrier located between an array and outside objects. The example of this insulation is shown in Fig. 21.

22. It is preferable to have the different groups of arrays placed in a staggered manner, not parallel to each other. It is shown in Fig. 22. The first group of electrodes are under the same potential as the ductwork walls. The second group is under high voltage. The second groups extreme electrodes are located father from the walls than the extreme electrodes of the first group. Being located this way the array covers more of the ductwork's cross area

than if the first group of electrodes would be under high voltage. The whole idea is to move the high voltage electrodes, if possible, as far away from the non-array's parts without minimizing the arrays effective area.

23. Another implementation of this idea is to develop a ductwork (or frame) shape. According to the invention the ductwork or frame parts must be bent to guarantee a safe distance between the electrodes and the ductwork (frame). The example is shown in Fig. 23. In this case any part of the ductwork (or frame) is located at a safe (breakdownwise) distance from the electrodes that are at the voltage (potential) different of the ductwork (frame) voltage (potential).

24. Being installed within a ductwork or ductwork's net (web) the arrays must be removable and replaceable from time to time. This must be done when the array is excessively contaminated or damaged. It will be appreciated if the ductwork has a slot (or other means) for an array installation. The array may consist of one or more frames supporting electrodes. To remove an array means to pull it out. To install it means to put it back or replace it. See Fig. 24.

25. Still another improvement may be achieved when the HVPS is programmable to produce high voltage changes in the course of time. This feature creates several new effects. First of all, the air velocity and volume per time becomes different. This makes EWG able to produce a desirable amount of air movement according to a preset program or outside condition. If, for example, more pollution passes through the EWG, greater voltage may be needed to clean the air. Another example is that by changing voltage, "low" and "high" settings of air volume may be achieved, comparable to conventional fans. Also temperature changes may require more cooling ability and, therefore, a greater voltage. A HVPS may change the output voltage in accordance with a preset program, or in accordance with an environmental condition, or to adjust airflow volume.

26. EWG designed for quick air movement response must be as inertialess as possible. Being inertialess by nature it still has its limits. This limit is a HVPS that may have slow response time. If, for example, the HVPS is made as a voltage multiplier, or HVPS has a big output filter capacitor, it can not change the output voltage quickly. To do so the HVPS must store a small amount of energy that may be dissipated or accumulated quickly. The HVPS for the EWG according to this invention contains at least two parts connected

together in series. The first part produces the first high voltage with no or a minimum device for smoothing output voltage. This means that no components for storing the energy are included. The second part has a HVPS that complements the first one's ripples by adding necessary voltage to the first voltage. This second part comprises of no or minimum devices for energy storing. In Fig. 25 an example of such a HVPS is shown. The HVPS shown in Fig. 25 is capable of changing output voltage quickly enough to control output voltage without sufficient inertia.

27. A EWG has a natural limit of capacity (air velocity) which is not big enough for some applications. To increase this capacity and air velocity several arrays are located in series, as is shown in Fig. 4 and described in the Claim 4 of present invention. To make this design more compact, the positive and negative electrodes will comprise of both the sharp and dull parts. The sharp parts of negative electrodes are directed (or located close) to the dull parts of the positive electrodes. The positive electrodes' sharp parts are directed in turn to the dull parts of the negative electrodes. The example of this location is shown in Fig. 26. It is necessary that that sharp parts of one group of electrodes must be located much further from the dull parts of the next group of electrodes with the same polarity. In this case, each pair of electrodes generates "an electron wind" directed from one row to the other. This air movement is further accelerated by the next pair of electrodes. This next pair consists of the sharp edges of the second row and the dull edges of the third row. The sharp edges of the third row together with the dull edges of the fourth row create the next pair of electrodes. Each following row is under sufficiently high voltage with respect to the previous one. The positive and negative voltages are applied to the neighboring row in turn. According to another implementation of the above idea the electrodes are hollow to reduce weight and price.

28. While a single array is able to produce different wind velocity depending on the high voltage magnitude several arrays may produce not only different air velocity, but different air directions. A good example of this is a set of two arrays located at a certain angle to each other. Let us take (just as an example, but not limited to) a 90° angle as it is shown in Fig. 27. It may be any other angle as well. Let us first consider, that the high voltage is applied to the array #1 while the array #2 is under zero voltage. The wind will be directed orthogonal to the array's #1 electrodes (direction #1 in the Fig. 27). When high

voltage is applied to array #2 and zero voltage is across array #1, the wind is flowing in direction #2 in Fig. 27. When the equal high voltage is applied to the both arrays, each one tends to blow the air in its own direction. The array #1 blows to direction #1. The array #2 blows in t direction #2. If both arrays have an equal capacity, the resulting wind is blowing in direction #3, as shown in Fig. 27. If one of the high voltages is greater than the other, the wind blows in still different directions.

29. Having three arrays, as shown in Fig. 28, one is able to blow wind in any desirable direction.

30. HVPSs may produce different high voltages over time. The resulting air movement will vary. This creates a new effect of the air blowing in different (constantly varying over time) directions without any moving parts. The most obvious application of this wind generator is an oscillating fan. A conventional one comprises of at least two moving parts. One part comprises the blades forcing the air to move and another part rotates the set of blades ventilating a wider area. This oscillating fan may be substituted by, for example, two arrays, as shown, for example in Fig. 27. Each of these arrays is blowing the air in different, but intersecting directions. If one of the arrays blows the air in one direction, while another array blows the air in another direction, the combined forces of the two arrays will result in the air moving in a third direction. By changing the high voltage of each array separately one is capable of controlling the air velocity and the air direction. This may be achieved without any moving parts.

31. As an ultimate implementation of this idea, a number of arrays are located in space. They are connected to a number of HVPS. The number of arrays may be different from the number of HVPSs, i.e., the arrays may outnumber HVPS, or HVPS may outnumber the arrays. HVPSs may change their output voltages over time. This may be achieved by switching HVPSs' outputs or changing HVPSs output voltages. Each array produces more or less (or zero) wind velocity according to the voltage across its electrodes. The air will blow in the direction (or directions) and with force that is the result of the common propulsion of all the arrays. By this means one is able to produce the air movement in three dimensions with a desirable velocity in one or even more directions. It is necessary to say that all or any combination of the arrays may be of one-directional or bi-directional as well. The HVPS may change

their voltages to change the air velocity and directions in any desirable direction.

32. Still another implementation (and application) may be made using EWG as a "heat sink". The arrays are installed between a heat source and a place where heat is wished to be suppressed. A furnace on one side and laboratory equipment on the other side provide an example of this application. The arrays are located between these two places forcing the air to flow orthogonal to the line between the heat source and the location wished to be kept cool. (It may be any other angle as well). At the extension of the air direction a heat sink is located. It may be a heat sink or, say ,a hole in a ceiling, or other means for exhausting air which is desired to be kept separated. . The EWG "heat sink" may be used in different applications where a transparent (or a low cost) barrier is needed. It may be used for office, industry, electronic devices or technological applications as well. See Fig. 29 for the details.

33. Another EWG implementation is a flying apparatus. A light weight EWG with some of the electrodes located horizontally creates a lifting force that may cause it to fly (or hover). The horizontal (or close to horizontal) electrodes create a lifting vertical force, as it is shown in Fig. 30. Other wind directions that are created by EWG may be used for horizontal movement and maneuvers. Light weight electrodes are made from light weight (or hollow) material with a conductive surface. See Fig. 30. The HVPSs are connected to the arrays. The HVPSs may or may not fly with the arrays. If not, the HVPSs are connected to the arrays through light weight wires. It is preferable that the wires carrying different voltages are located apart from each other. By this they won't need a heavy high voltage insulation. As EWG needs only low power to generate air movement these wires must be of a small diameter and be light weight. The arrays themselves may be made of light weight hollow tubes with a geometry shown, for example, in Fig. 30. They may be made of plastic material, say, used for hot air balloons, covered with a thin conductive film. They may be filled with light weight gas like helium. Being light weight these devices need a small force to lift them up. In this way one is able to create a flying apparatus which is noiseless, and fully controlled in all directions. One more advantage of this apparatus is that it has much less inertia in comparison the hot air balloons and it is simpler than other hovercraft.

34. The flying apparatus described above may be used together with heating and cleaning features. Being fully controlled and able to fly in any direction this apparatus may be used for cleaning or heating (or other needs) of inaccessible areas, say, pipes or other enclosed or hazardous areas. Another implementation may be seen for the hermetically sealed areas which need to be constantly cleaned. Being located inside of such area and powered from HVPSs, the flying air conditioner (which means cleaning, heating and either abilities described above) may be directed to the desirable objects and remove (actually, collect) dust or other contamination from these objects. It may also heat desired objects or treat them within the ability of EWG described above. After the technological process is accomplished the area is opened and EWG with collected dust may be removed and cleaned or it may be returned for continuation of the process.

35. The flying EWG may be used for explosive gases control. It is a well-known problem in the mining industry, where undesirable methanol concentration happens from time to time. For safety reasons it is desirable to ignite these concentrations prior to the time when they will exceed a safe level. Some of these areas are inaccessible and this prevents an effective explosive gases control. The EWG combines the ability to fly with the ability to create sparks between its electrodes. The spark frequency (or presence) may be controlled by the high voltage magnitude that is applied between the electrodes. The flying EWG may be directed to an inaccessible area. After it reaches this area the HVPS increases the high voltage magnitude between the electrodes creating one or more sparks between the electrodes. The sparks thus ignite the explosive gases and reduce their concentration.

36. It is desirable for some applications to produce a pulse in the air movement (gusts). EWG is capable of producing a more powerful wind during a short time, i.e., pulse action. It needs some background to comprehend. EWG capacity is limited by breakdown the limit of the gap between the sets of electrodes having opposite high voltage polarity. The closer it is operated to the breakdown limit the more wind velocity it will generate.. It is well known, that short high voltage pulses tend to have a higher breakdown limit than continuous high voltage. This means, in turn, that when a pulse voltage is applied to the array it may create greater air movement than when continuous high voltage is being applied to the same array. This accelerated air movement exists, only, for the time the pulse voltage is applied. The shorter

the pulse width is, the greater the voltage may be applied without breakdown. The higher the pulse frequency is, the more constant the air velocity will be that is generated. One of the pulse EWG applications may be a wind tunnel. Wind tunnel tests for aircraft stipulate that along with a steady air flow, a pulse (or quickly changed) air movements are needed as well. These quick air movements may be useful for simulating real atmosphere conditions. Conventional blowers by design have inertial limits which make them unable to produce the sharp, quick change in air movement desired. The pulse EWG may be used for such a test (simulation or modeling).

37. When the arrays are connected in series the high voltage is distributed unevenly through them (See Fig. 31 for the details). Some of the arrays have smaller gaps and corona discharge is initiated at the lower level. The breakdown level is also different for the different arrays. Being connected in series one of the array's air gap may breakdown earlier than the others. This series connection may be used for the above mentioned pulse action. one of the arrays can be predetermined to have a low breakdown level. When the HVPS voltage reaches a certain level the voltage across this array exceeds the breakdown level. The spark will then occur between the electrodes of this array. The HVPS voltage across the other arrays becomes greater and they will produce more wind. It will be appreciated, if any other device is used for the pulse initiation without departure from the spirit of this invention. The main distinguishing feature is the series of connections of the initiator array (or the air gap, or discharge tube, or whatever) with the other array (or arrays).

38. The array with the different distance between the electrodes is shown in Fig. 32. The aim of the different air gaps is to direct the air in the desired direction. The closer the rods of the array are, the stronger the wind is in this area. The array with arbitrary gaps may direct the air flow as a result of all the flows produced by the array's parts. The array shown in Fig. 32a generates more wind by the ends than by the middle parts of the array. Being designed this way the array blows the wind as a directional aerial. The "side lobes" may be suppressed or amplified. The same array may be made with the middle parts closer to each other than side parts. That array will generate a wind with more of a rounded shape (See Fig. 32b).

39. The EWG is comprised of a number of electrodes and a means (stands, walls, or platforms) for their moving. This EWG (see example in Fig. 33) may blow wind in different directions and with different forces. These directions

and forces depend on the electrodes mutual location. This EWG may blow wind in different directions and with different forces having, for example, one HVPS.

40. The ultimate EWG systems are comprised of a number of arrays (or wind generators) together with other heating, cleaning (described above) devices, sensors and improvements. This system has one or more HVPS and also low voltage power supplies, connected to the electrodes of the number of arrays. The control system monitors and changes the high voltage at the each electrode to maintain the necessary air velocity, heat, cleaning ability, etc. that is desired. This EWG system may be part of, say, a buildings air conditioning system.

41. For most applications the sharp and dull edges of the different rows of electrodes must be located at the same distance from each other. This requires a lot of precise work and labor. To facilitate this requirement the array comprise flexible, but sharp, edges. These edges, which serve as the corona emitting parts, (or corona electrodes themselves, or parts of corona electrodes) are flexible and/or movable. They are able to move (float, bend, etc.) to their desired location, geometry, and shape, once wind and electrostatic forces are introduced. The aim is to allow the sharp edges to arrange themselves into uniform (electrostatic wise) mutual shape. All of the sharp edges will maintain an equal distance from the opposing dull rods. It may be seen as an array of hollow tubes (flexible or rigid) with threads (fringe) located on one side. These tubes and edges (fringe) are made of conductive material.

42. Another implementation of this idea (I. 41) are flexible electrodes (Fig. 35). If some part of the electrode produces more strong wind than another, it will repel from the opposite electrodes and increases the distance (the gap) between these electrodes.

43. The EWG may generate not just air movement but also sound. This fact is well known. The EWG produces a sound when high voltage, applied to the array, changes the magnitude of the frequency within the sound range. The EWG shown in Fig. 36 has a sound sensor (mike) and HVPS that changes its output voltage in accordance to the incoming sound (going in the EWG direction). The air movement that is produced by the EWG is flowing in the opposite direction (it meets the incoming sound). The wind, produced by EWG, is of the same intensity (velocity) as the incoming sound and eliminates (or, at

least reduces) this sound. The timing diagram in Fig. 37 illustrates the performance of EWG.

44. The "sound barrier" may be combined with air movement. To do so EWG must be supplied with a stable high voltage to produce the air movement. At the same time EWG must be capable of changing voltage to prevent sound penetration. This changeable portion of the high voltage must be less than the stable portion. The maximum combined voltage must be lesser than breakdown level. The minimum combined voltage is greater than the corona level. The average high voltage magnitude is big enough to produce a desirable amount (velocity) of air movement.

45. The sound barrier, based on the principle described in i. 43, consists of a number of arrays and a number of HVPSs. Each HVPS is equipped with a sound sensor (microphone) and a control system that changes the output voltage of each HVPS. The HVPS is of an inertialess type, which was discussed above in ii. 25. The HVPS produces just enough high voltage to generate air movement of opposing polarity to that of the sound entering to the array. This implementation eliminates (or, at least, reduces) all of the sound going to the number of arrays. This may be called "a clear sound barrier".

46. When several pairs of the arrays are located in sequence, there must be sufficient distance maintained between the different pairs of electrodes to keep them from interacting with each other. As shown in Fig. 37, the electrode 3 may interact with the electrode 2. In this case electrode 3 pushes the air molecules toward electrode 2. This the air movement is opposite to the air movement, produced by the electrodes 1 and 2. Thus EWG efficiency is decreased. To prevent this opposite action the interaction between the electrodes 3 and 2 (as well, as similar) must be decreased. The cross location of the arrays is shown in Fig. 38. The arrays are located at a 90° angle (but may be located at another angle). The area of interaction between the electrodes is lesser than, say, in Fig. 37. Being designed this way, several arrays may be located closer to each other without decreasing the efficiency.

47. The EWG may simultaneously move the air and clean it. To do so the particulates in the air must be charged by the opposite polarity of the electrodes they are passing by. In the Fig. 26 all the particles are being charged in turn negatively and positively. They are passing by the electrodes having the opposite polarity and are attracted to these electrodes and stick to them. The air leaves the invention with less particulate than when it entered.

To increase the particulate collecting ability, some of the electrodes (say, having the same polarity) have more length in the air flow direction than the electrodes with the opposite polarity. The particulates are collected on these longer electrodes. This EWG (Fig. 39) has a greater ability to clean the air (collect the particles).

48. Another improvement of the idea (i. 47) is that at least some of the electrodes have a developed surface. This development creates a turbulent air movement near the surface. Being involved with the turbulent movement the particulates spend more time near the surface. During this extended time the particulates are attracted to the surface and stick to it. This improvement increases the time of the particulates' attraction that, in turn, increases the EWG ability to clean the air. See Fig. 40.

49. When several arrays are located in sequence (i. 4) the first array accelerates the air while the following arrays push the already accelerated air to still higher velocity. This "series EWG" has a natural air movement limit. This limit is an ions' (or electrons') velocity. The air velocity can not exceed the velocity of ions (or electrons), which actually push it. The ions' (or electrons') velocity depends on the voltage between the electrodes. The more voltage the more the ions' velocity and the more the air movement velocity increases. The Fig. 41 shows the EWG with increased air movement efficiency. The EWG consists of several arrays with different (they may be equal, as well) air gaps. Each arrays is fed by a different HVPS. Each array in the sequence is fed (as a rule, but not limited to) with greater voltages than the previous ones. The arrays with greater air gaps are preferably fed by greater high voltage. The air being accelerated by the first array is more accelerated by the following array that emits ions (electrons) with greater speed. The EWG shown in Fig. 41 combines efficiency and compact design with a great acceleration ability.

50. Still a further improvement of this idea is the EWG shown in Fig. 42. It comprises of a lesser number of HVPS than the arrays' number. The EWG may consist of one multioutput HVPS and several arrays connected to it. As the example (but not limited to) the multioutput HVPS may be either a modular HVPS, or a HVPS with taps (a transformer, fly-back converter), or a voltage multiplier with taps from different stages, or any other multioutput HVPS.

51. The distance between the electrodes is critical for the EWG's performance. This distance may change because of particles collected on the

electrodes. Some of particles are small in size and do not greatly contaminate the electrodes. They create a thin even layer on the electrodes. But, there are bigger particles that, having settled on the electrode decrease the air gap between the electrodes and may cause a spark or ark discharge. A thin thread, cotton, fiber, or hair may be good examples of the contamination that may prevent an EWG to work properly. When these kinds of contamination are present an EWG needs some sort of pre-filter, which will trap and thus prevent large particulate from entering the EWG . This filter (Fig. 43) may be of any kind. It may be a fabric filter, or it may be an electrostatic filter, or any other kind which will meet the demands of this invention.

52. The thin electrodes (or corona electrodes, or sharp edges) may be of any shape. The only condition which must be satisfied is that the sharp edges must be sufficiently sharper than the dull edges of the opposing electrodes. They must emit the electrons or ions much more freely than the dull rods opposing them. The sharp edges may be made of a thin wire (tungsten wire with the diameter of 0.04", for example), or of knife blades, or barbed wire, or of any other shape, which satisfies the above condition. As a good example of a good sharp electrodes may serve a saw blade, especially a wood saw. It is, first of all, sharp enough to emit the electrons or ions as well. The teeth are set and may be directed to the dull parts of another group of electrodes, which are located in a staggered order. An additional advantage of this saw application is that the electrodes are inexpensive, because of the well developed tool manufacturing industry. As the corona electrodes may also serve a long razor blades. They are used for scraping floors and other flat surfaces.

An advantage of the above design is that it comprises no moving parts to move, clean, direct, block, and heat air or other gaseous matter. This means in practice that the air may be moved without inertia. (There is no lag time, the air moves instantly when the invention is turned on.

A further advantage is that the electrostatic wind generator is noiseless, or, at least much less noisy than conventional fans. The corona discharge sound it produces is much more quiet and more pleasant for human hearing. (white noise, murmur).

Another advantage is that very little energy is needed for the same productivity. Some experiments give the data (see below) that the electrostatic fan is 3 to 10 times less power consumptive than a conventional fan with the same capacity.

It may be understood because an electrostatic generator uses a direct electrical to mechanical power conversion. A conventional fan, on the other hand, needs to rotate blades first and wastes a sufficient amount of power to keep them moving.

Still another feature is the ozone production and moving at the same time. The corona discharge produce sufficient amount of ozone which may be delivered at any desirable direction.

I hereby declare that High Voltage Integrated LLC, Unified Business License ID # 601 761 755 located at 13910 SE 23rd St, Bellevue, WA 98005, is a small business as defined for the purposes of applying for a provisional patent. High Voltage Integrated is composed of 5 members and has no employees.

Ingrid T. Fuhriman

Ingrid T. Fuhriman

VP High Voltage Integrated

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

INVENTOR(S)

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IGOR	KRICHTAFOVITCH	BOTHELL, WA.

☐ Additional inventors are being named on the ___ separately numbered sheets attached hereto

TITLE OF THE INVENTION (280 characters max)

ELECTRON WIND GENERATOR

CORRESPONDENCE ADDRESS

Direct all correspondence to:

___ Customer Number [ ] → Place Customer Number Bar Code Label here

Type Customer Number here

OR

___ Firm or Individual Name: HIGH VOLTAGE INTEGRATED

Address: 13910 SE 23RD ST.

Address:

City: Bellevue State: WA ZIP: 98005

Country: UNITED STATES Telephone: (425) 746-9647 Fax: (425) 746 0719

ENCLOSED APPLICATION PARTS (check all that apply)

___ Specification Number of Pages: 73 ☒ Small Entity Statement

___ Drawing(s) Number of Sheets: 51 ☐ Other (specify)

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT (check one)

___ A check or money order is enclosed to cover the filing fees

___ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number:

FILING FEE AMOUNT ($)

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

___ Yes, the name of the U.S. Government agency and the Government contract number are: ___

Respectfully submitted,

SIGNATURE [signature] Date / /

TYPED or PRINTED NAME: R.L. FUHRIMAN JR.

REGISTRATION NO. (if appropriate)

Docket Number:

TELEPHONE: (425) 746-9647

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PROVISIONAL APPLICATION COVER SHEET
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INVENTOR(S)/APPLICANT(S)		
Given Name (first and middle [if any])	Family or Surname	Residence (City and either State or Foreign Country)
Igor A.	Kriohtafovitch	822 233 St SE Bothell, WA, 98021
Robert L.	Fuhriman	13910 SE 23rd St. Bellevue, WA 980

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STATEMENT CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) & 1.27(b))—INDEPENDENT INVENTOR	Docket Number (Optional)

Applicant, Patentee, or Identifier: Bob Fuhriman

Application or Patent No.:

Filed or Issued:

Title: Electron Wind Generator

As a below named inventor, I hereby state that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office described in:

- [ ] the specification filed herewith with title as listed above.
- [ ] the application identified above.
- [ ] the patent identified above.

I have not assigned, granted, conveyed, or licensed, and am under no obligation under contract or law to assign, grant, convey, or license, any rights in the invention to any person who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern, or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- [x] No such person, concern, or organization exists.
- [x] Each such person, concern, or organization is listed below.

~~High Voltage Integrated~~

Separate statements are required from each named person, concern, or organization having rights to the invention stating their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

Bob Fuhriman	Igor Kriaktafovitch	
NAME OF INVENTOR	NAME OF INVENTOR	NAME OF INVENTOR
Rob Fu	Igor Kriaktafovitch	
Signature of Inventor	Signature of Inventor	Signature of Inventor
10-10-98	10.16.98	
Date	Date	Date

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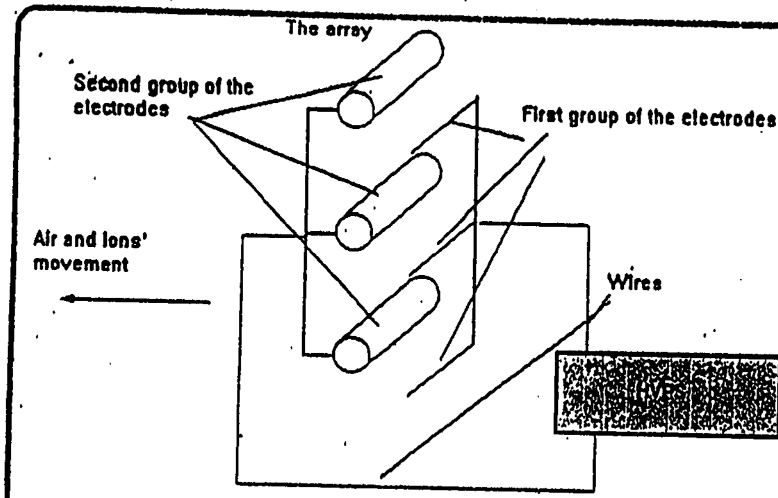

Figure 1

Electrostatic Wind Generator

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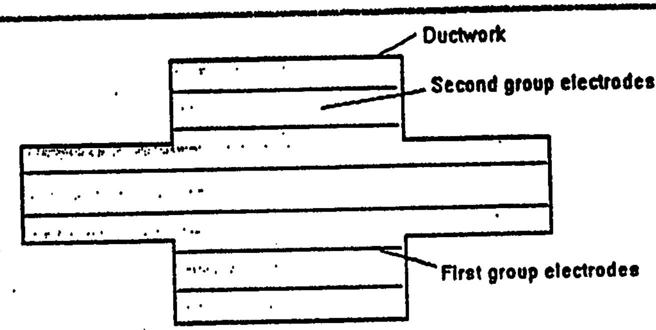

Figure 2

Electrostatic wind generator

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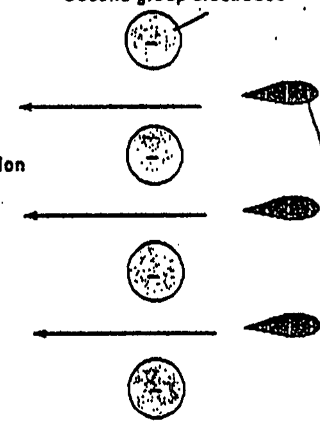

Figure 3

Electrostatic Wind Generator

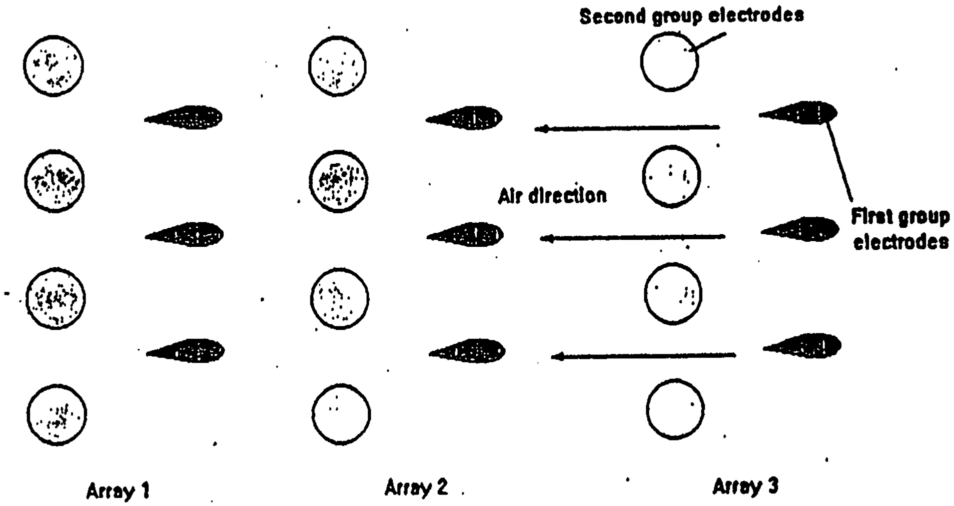

Figure 4

Electrostatic Wind Generator

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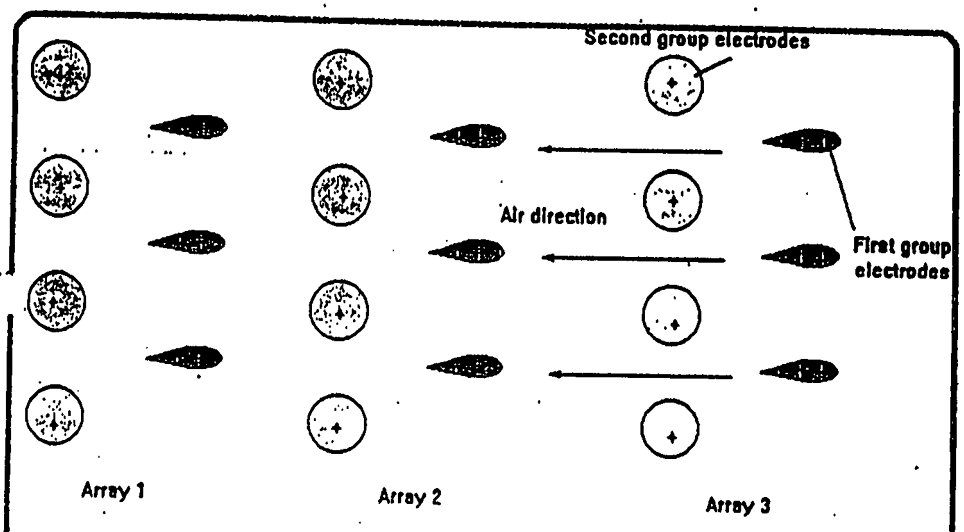

Figure 5

Electrostatic Wind Generator

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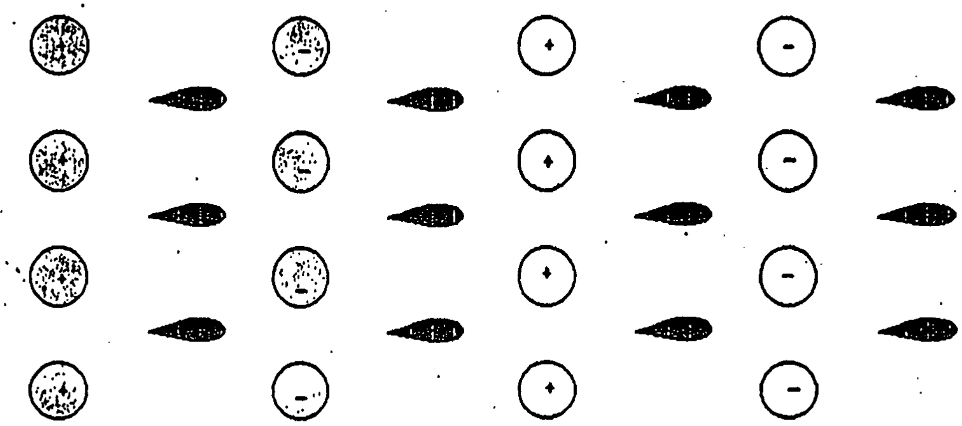

Figure 6

Electrostatic Wind Generator

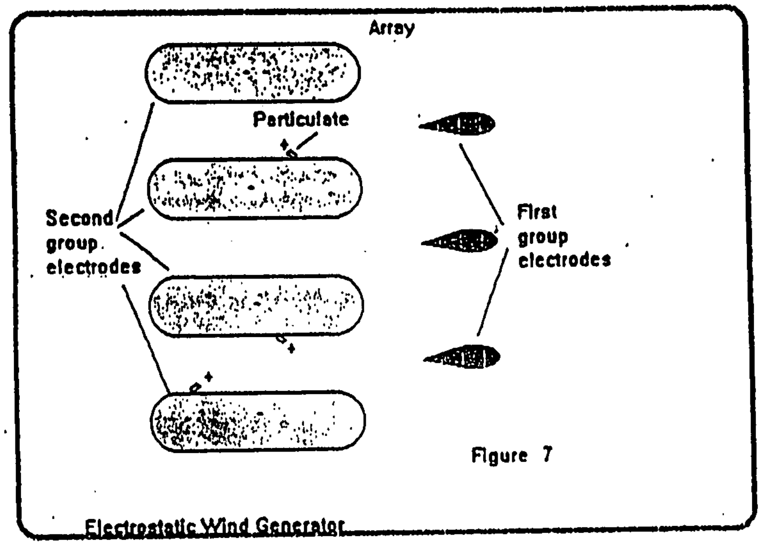

Figure 7

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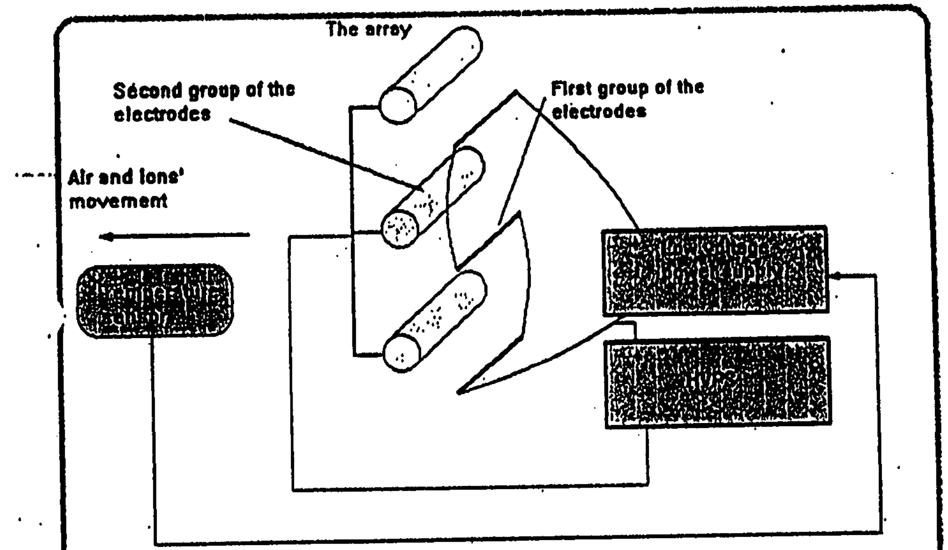

Figure 8

Electrostatic Wind Generator

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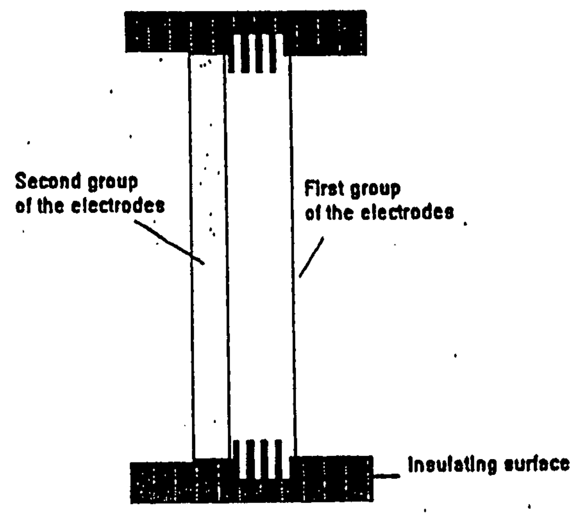

Figure 9

Electrostatic Wind Generator

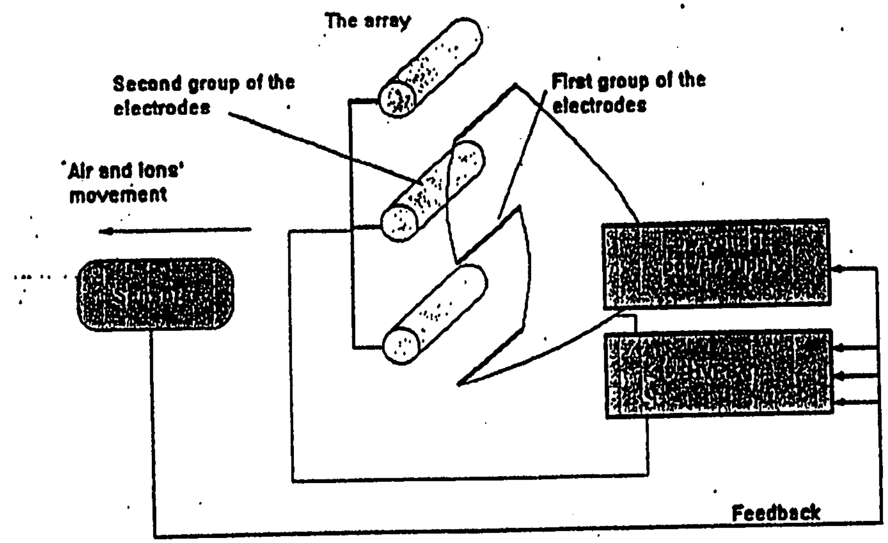

Figure 10

Electrostatic Wind Generator

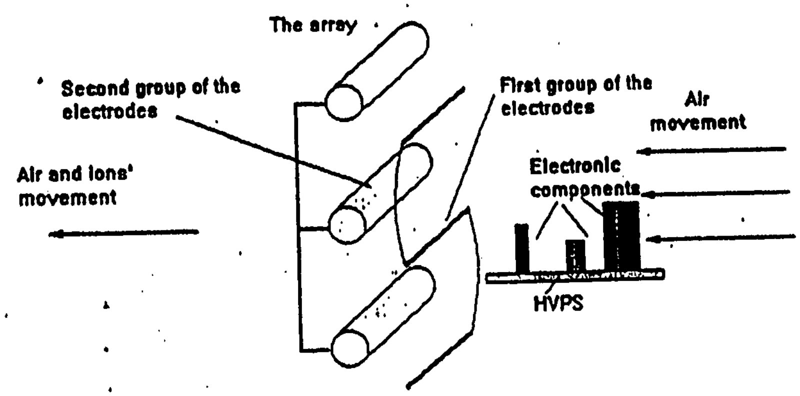

Figure 11

Electrostatic Wind Generator

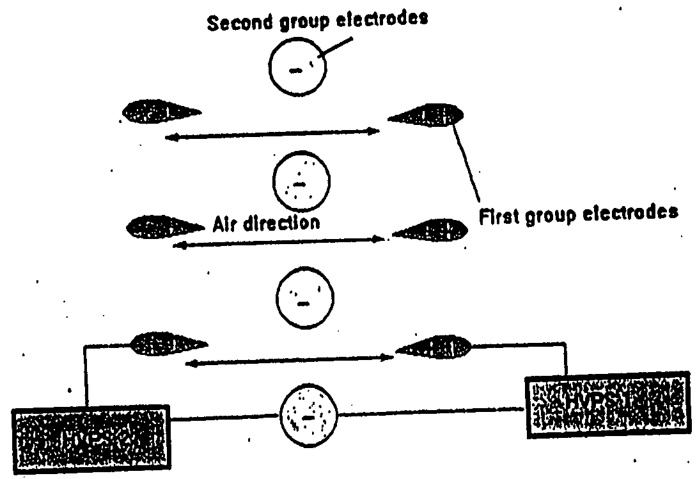

Figure 12

Electrostatic Wind Generator

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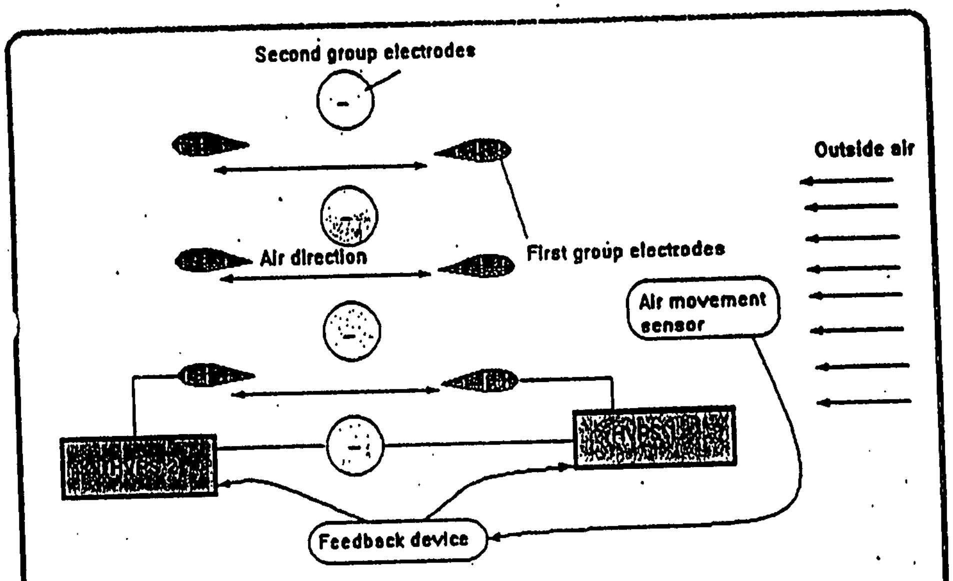

Figure 13

Electrostatic Wind Generator

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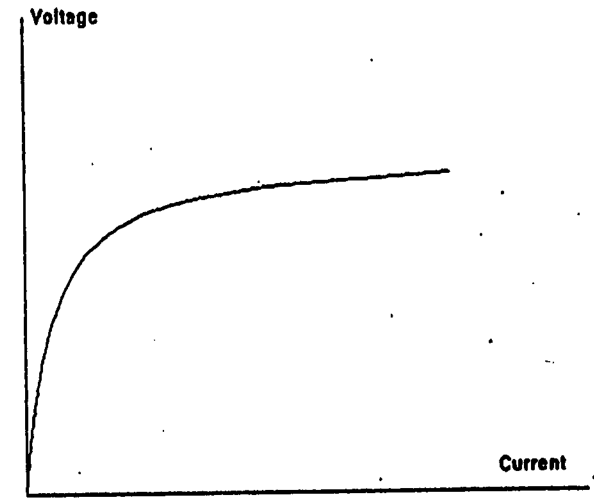

Figure. 14

Electrostatic Wind Generator

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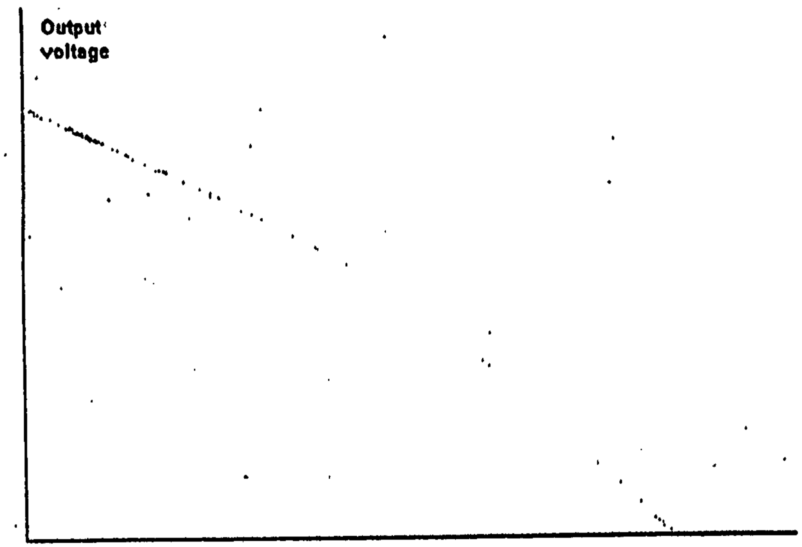

Electrostatic Wind Generator

Figure 15

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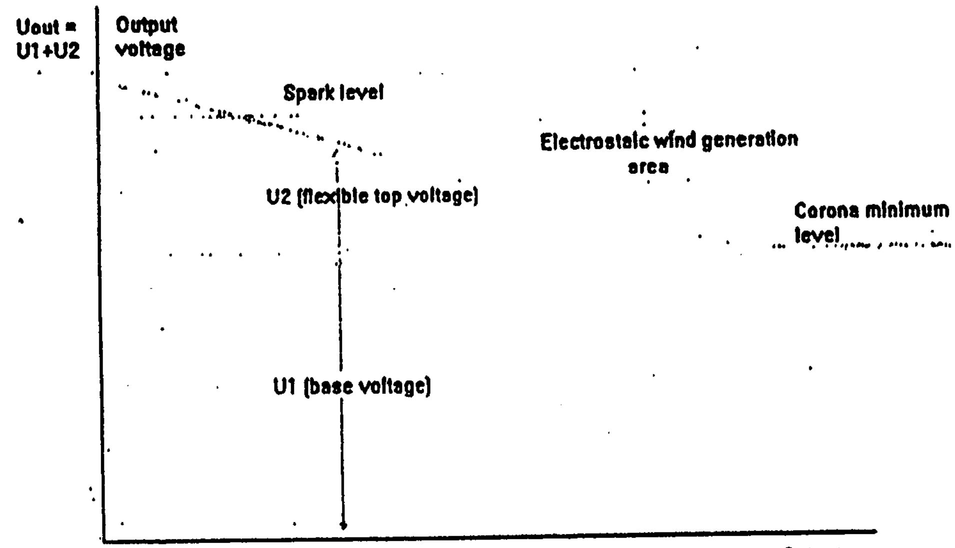

Electrostatic Wind Generator

Figure 16

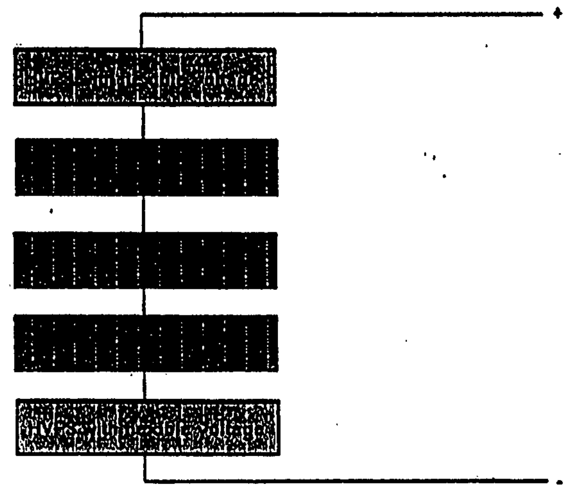

Figure 18

Electrostatic Wind Generator

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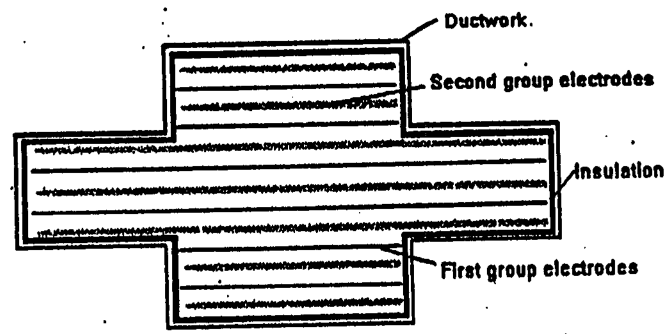

Figure 21

Electrostatic Wind Generator

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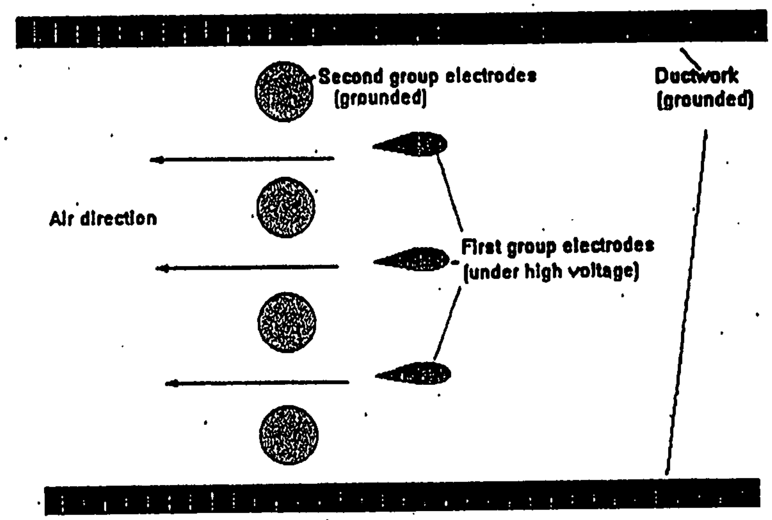

Figure 22

Electrostatic Wind Generator

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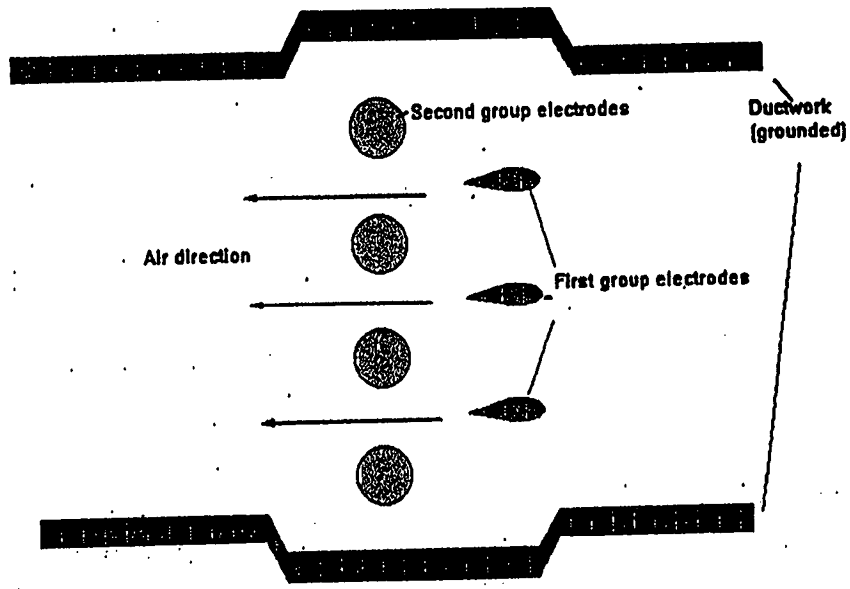
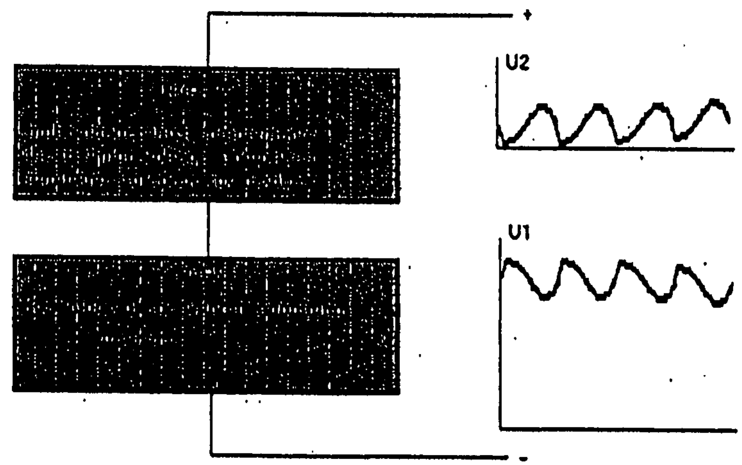


Figure 23

Electrostatic Wind Generator



Electrostatic Wind Generator

Figure 25

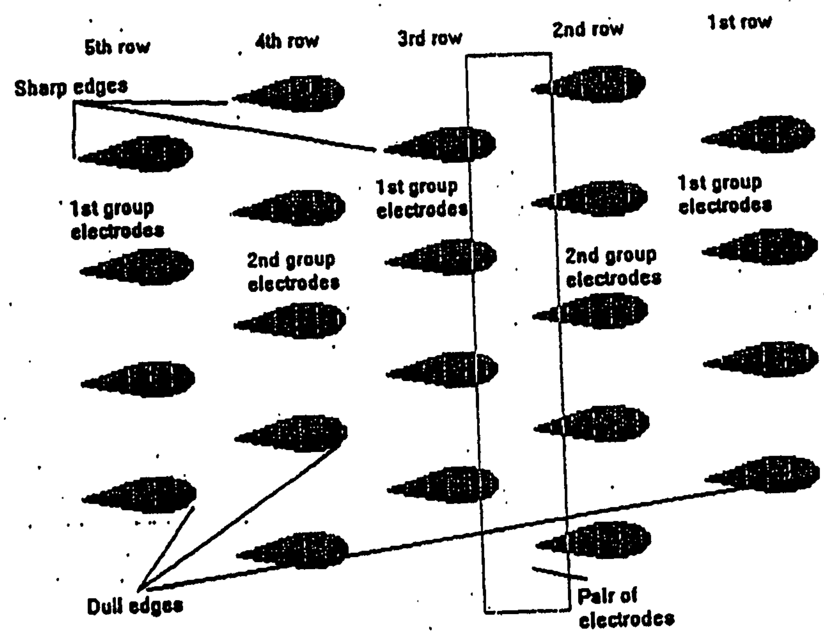


Figure 26

ctrostatic Wind Generator

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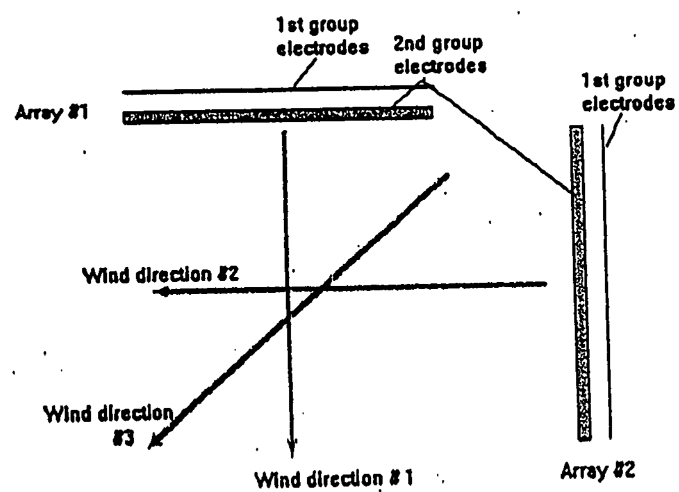
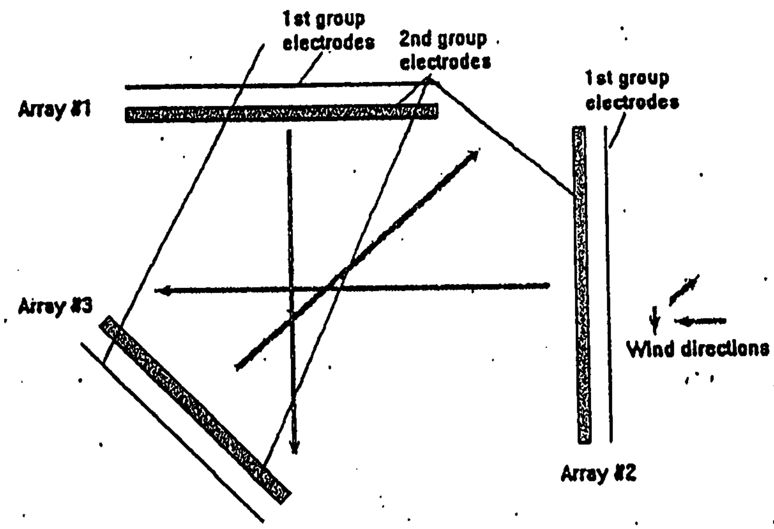


Figure 27

Electrostatic Wind Generator



Electrostatic Wind Generator

Figure 28

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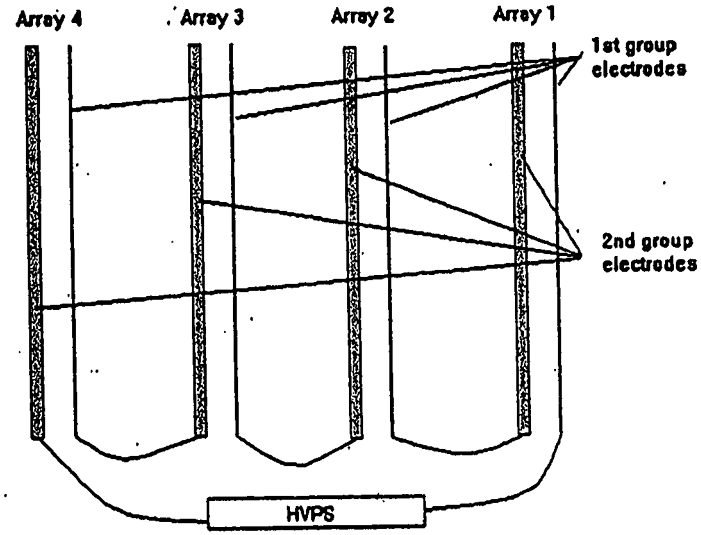
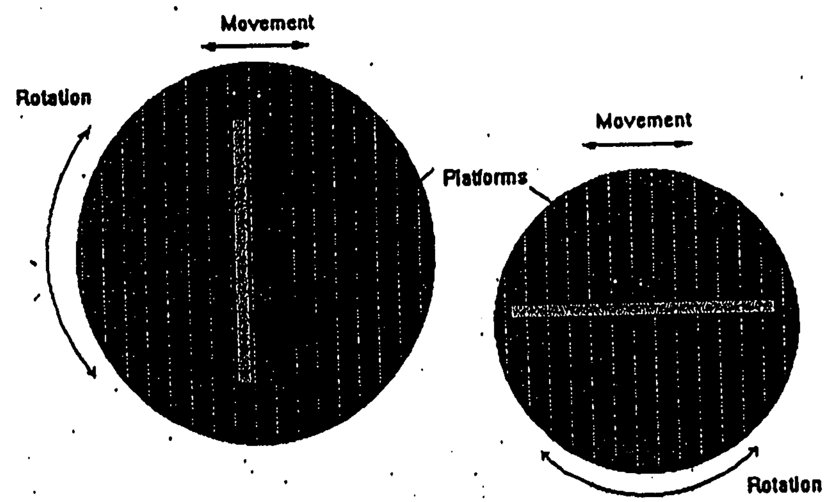


Figure 31

Electrostatic Wind Generator



Electrostatic Wind Generator

Figure 33

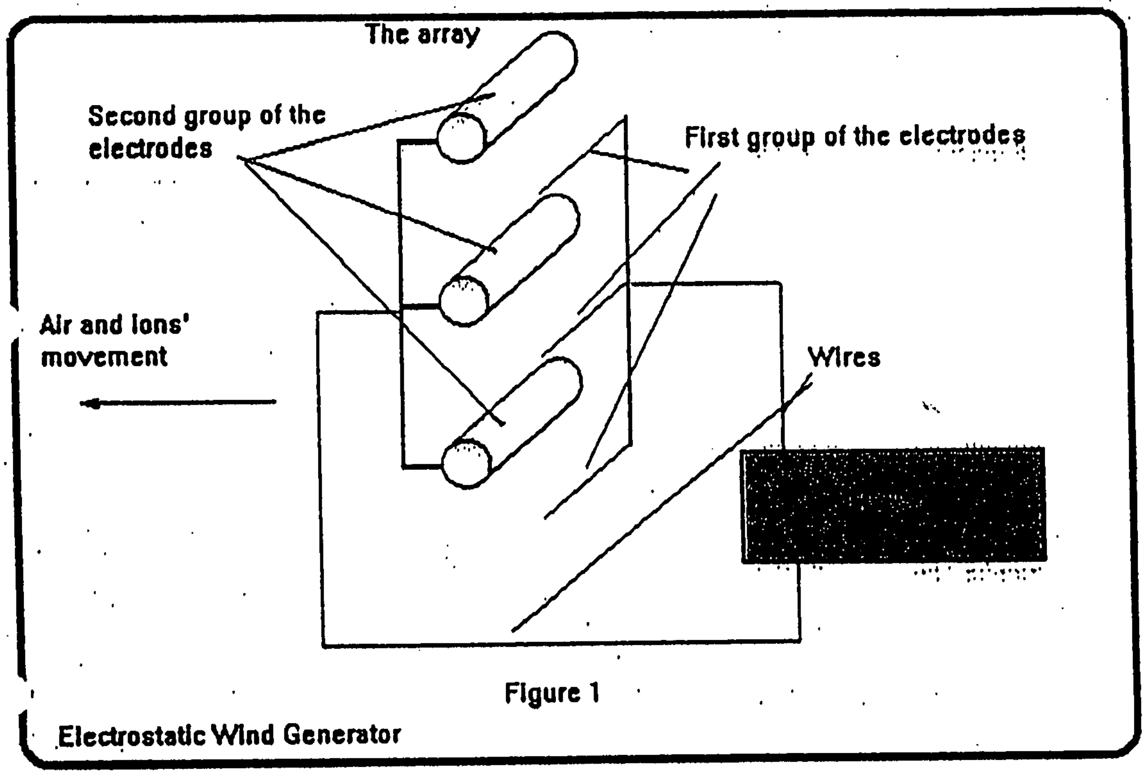


Figure 1

Electrostatic Wind Generator

60104573.101698

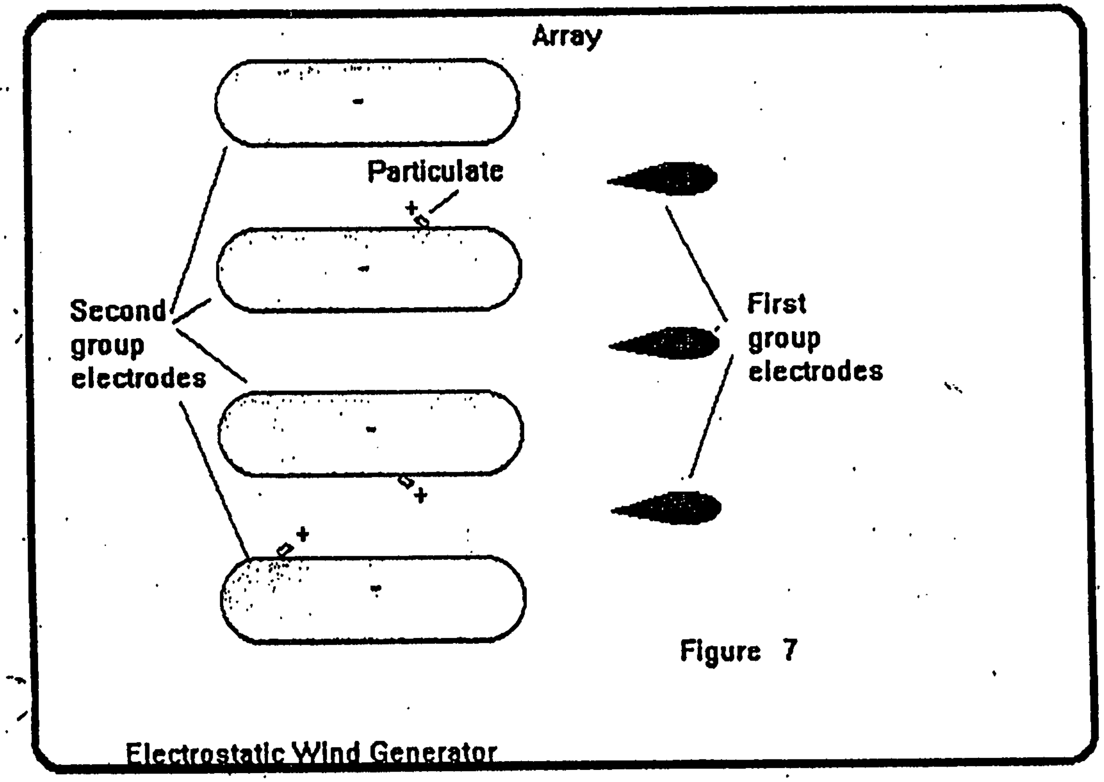

Array
Particulate
Second group electrodes
First group electrodes
Electrostatic Wind Generator

Figure 7

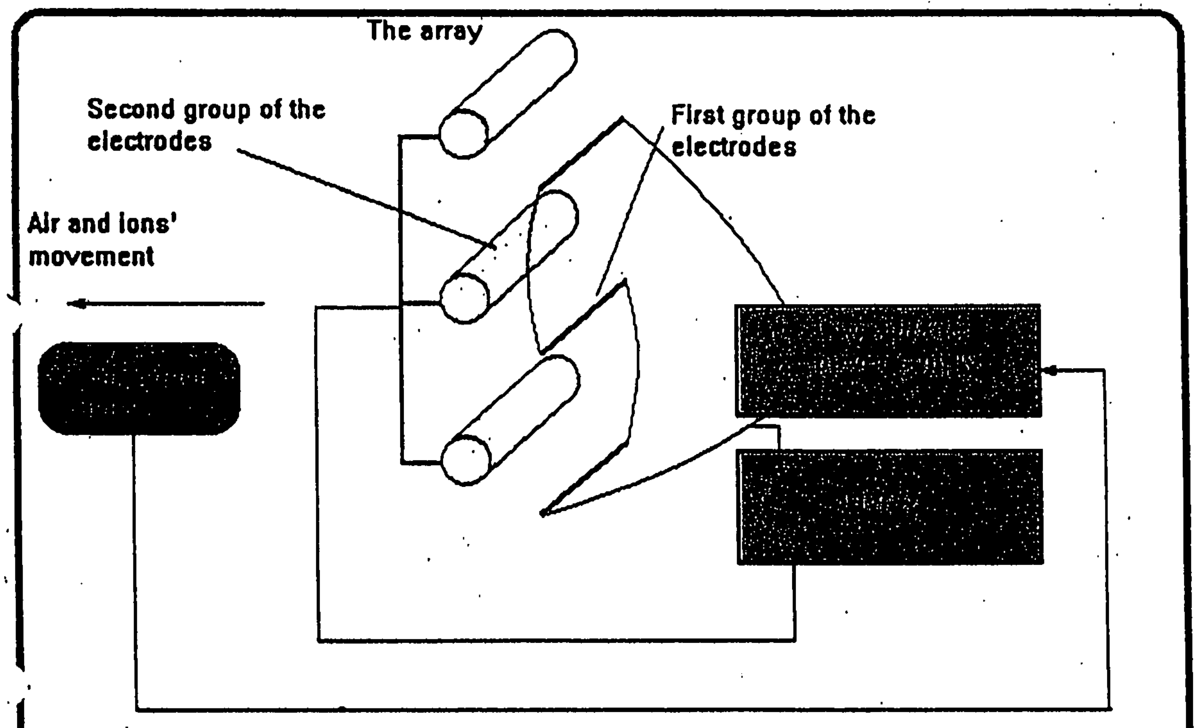


Figure 8

Electrostatic Wind Generator

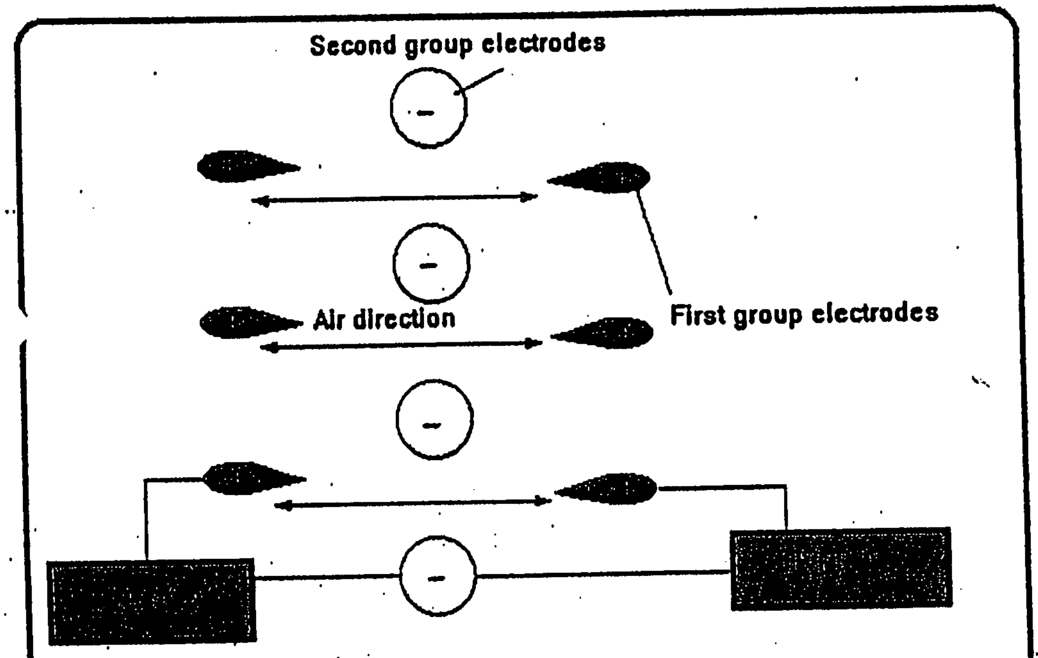
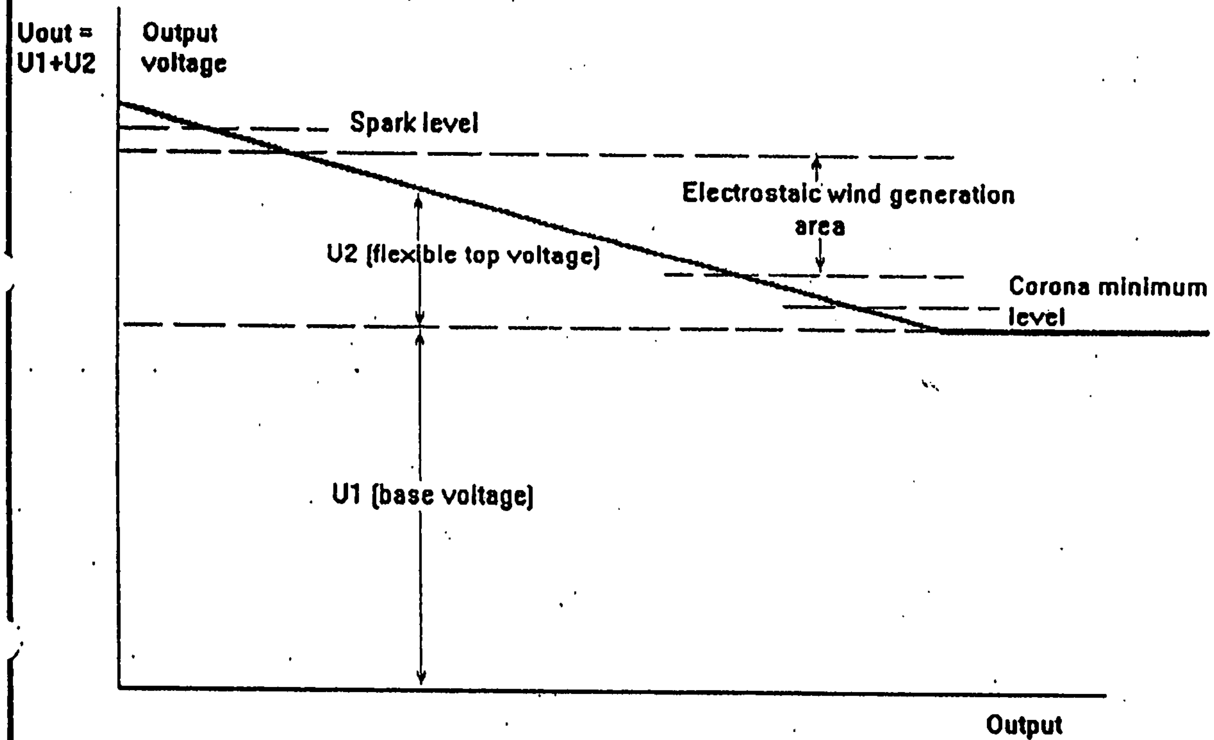

Second group electrodes
Air direction
First group electrodes

Figure 12



Electrostatic Wind Generator

Figure 16

60104573.101698

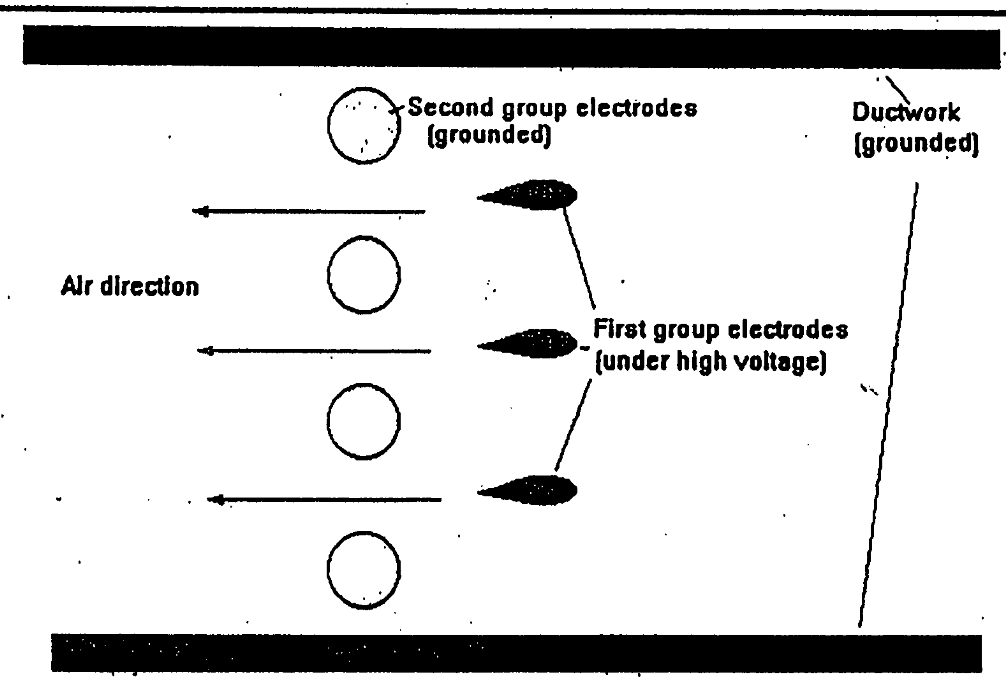


Figure 22

Electrostatic Wind Generator

60104573.101698

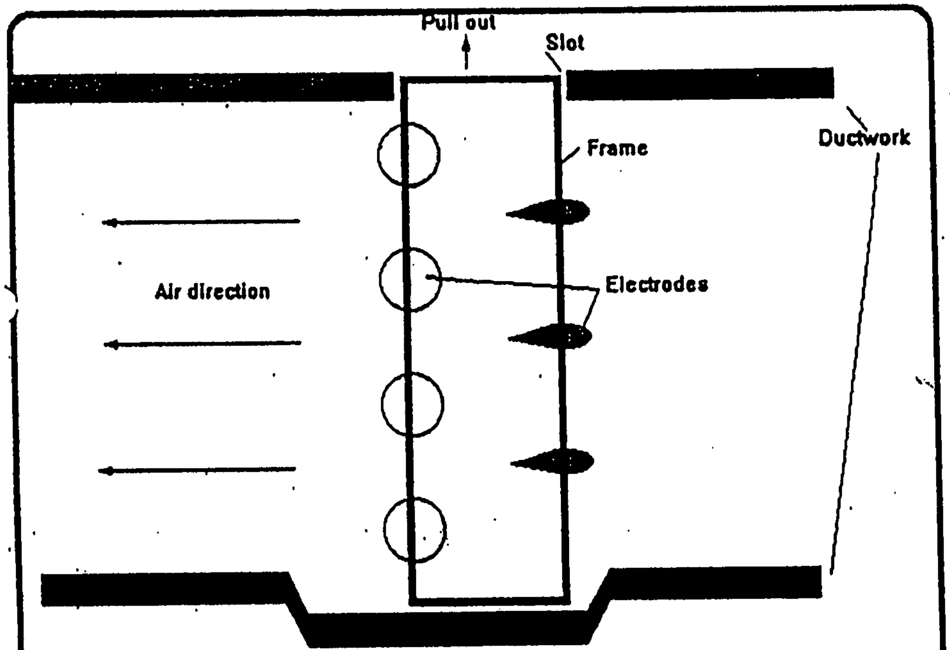
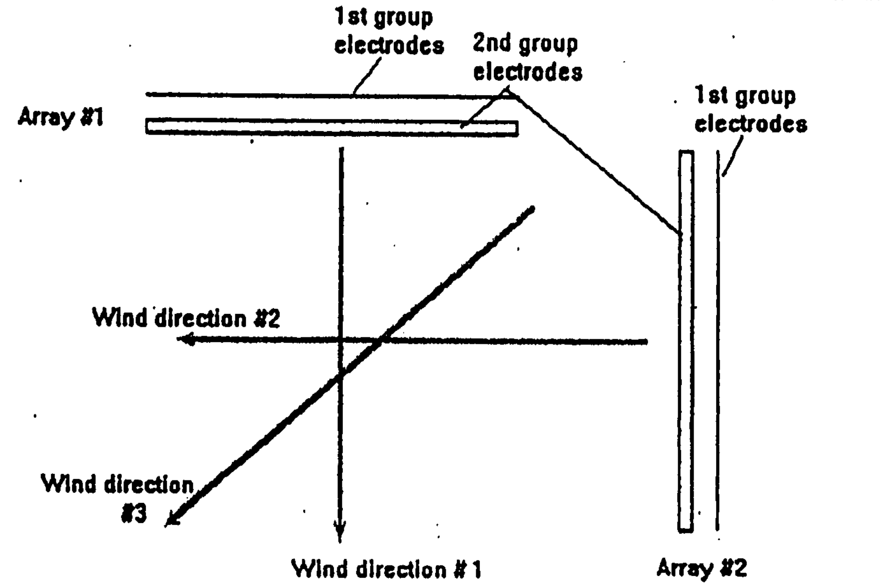


Figure 24

Electrostatic Wind Generator

60104573.101698



Electrostatic Wind Generator

Figure 27

60104573.101698

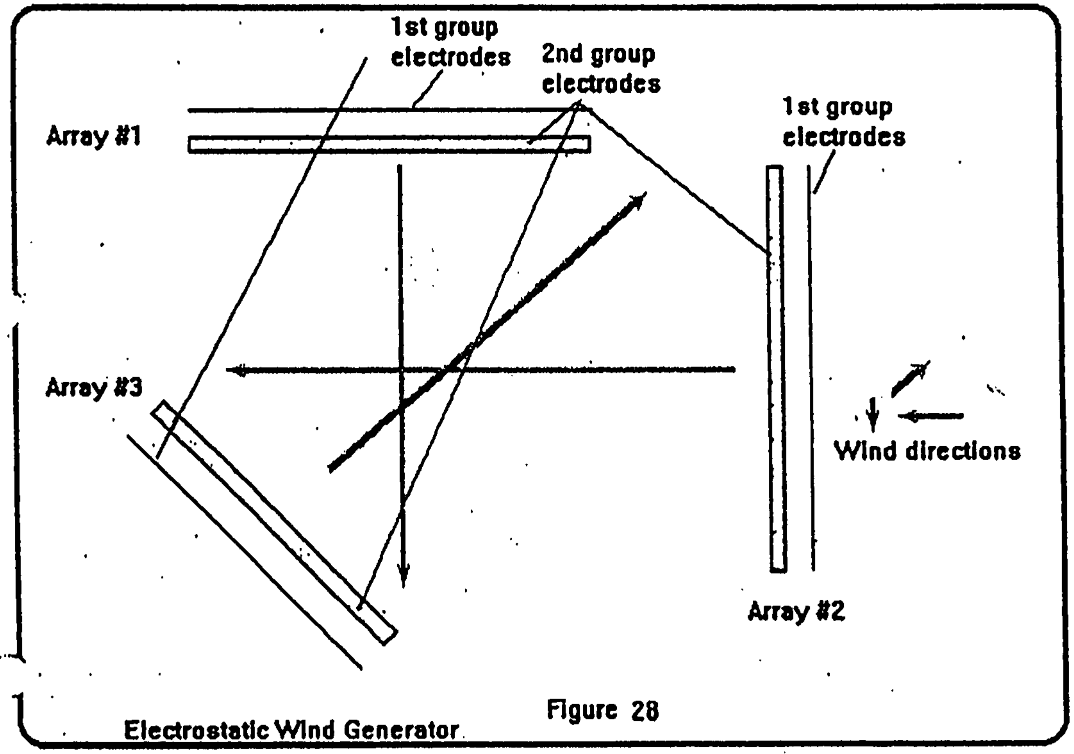


Figure 28

60104573.101698

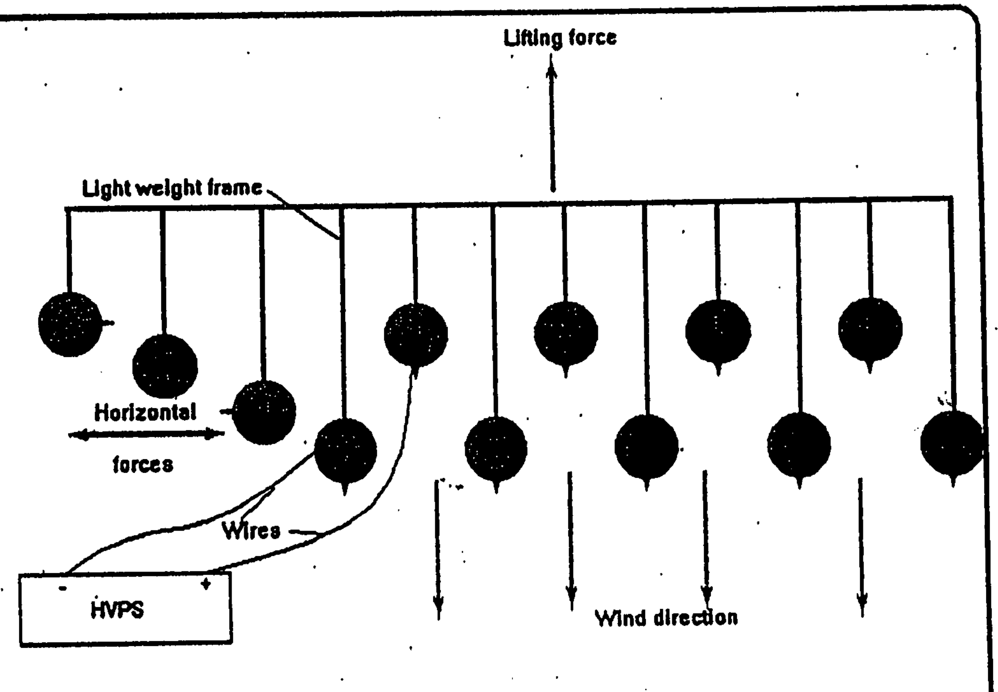


Figure 30

Electrostatic Wind Generator

60104573.101698

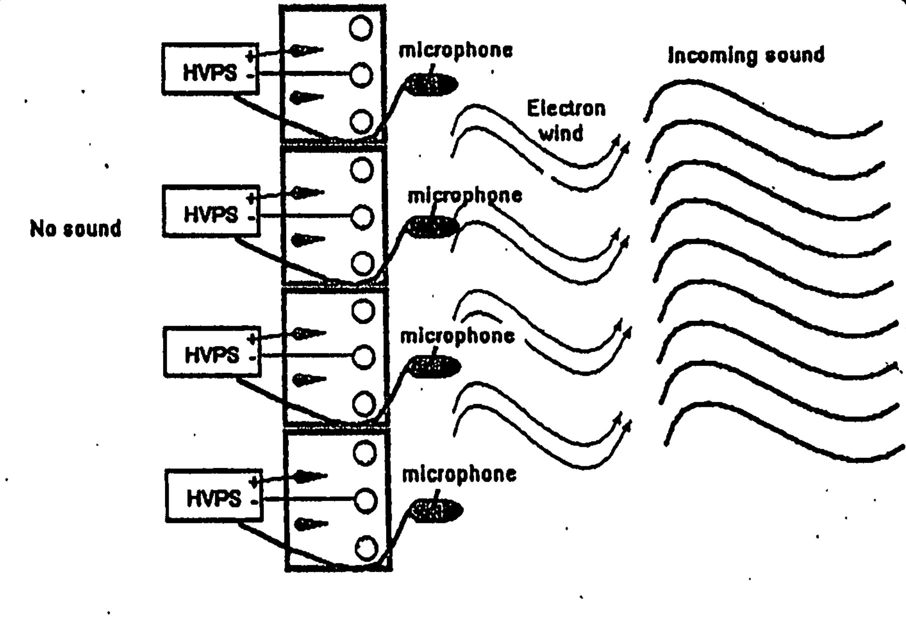


Figure 36

Electrostatic Wind Generator

60104573.101698

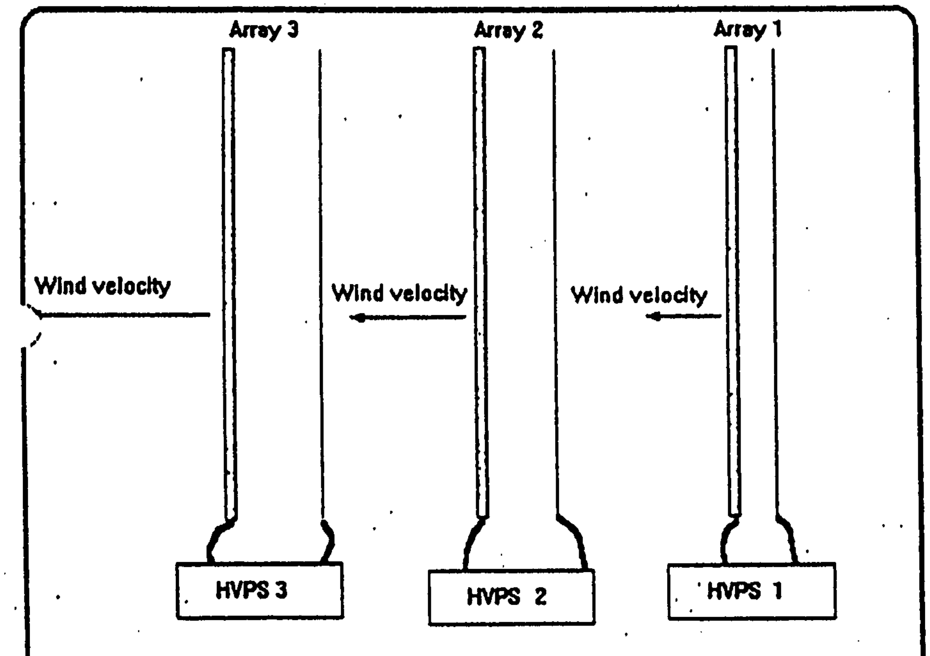


Figure 41

Electrostatic Wind Generator

60104573.101698

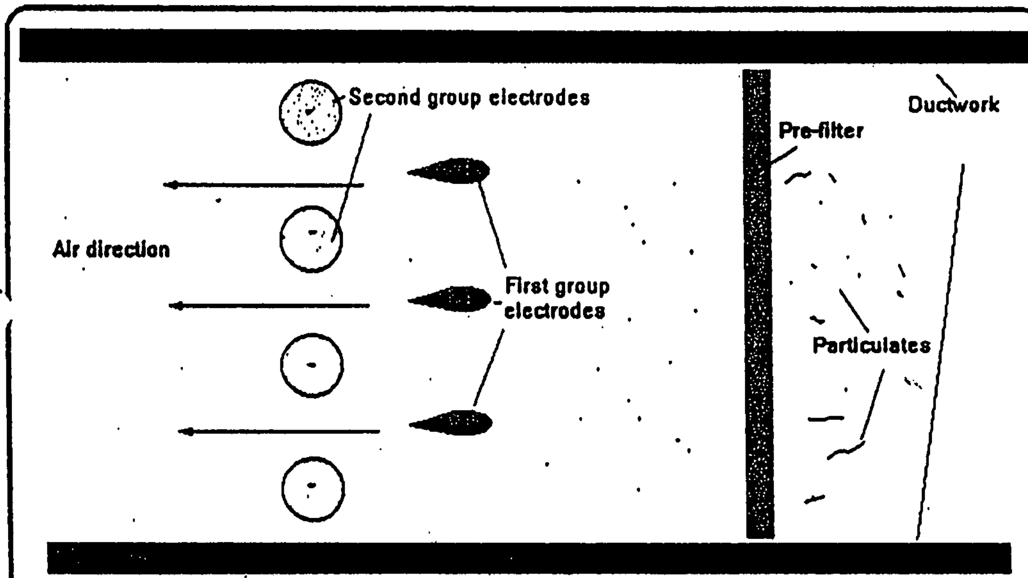


Figure 43

Electrostatic Wind Generator

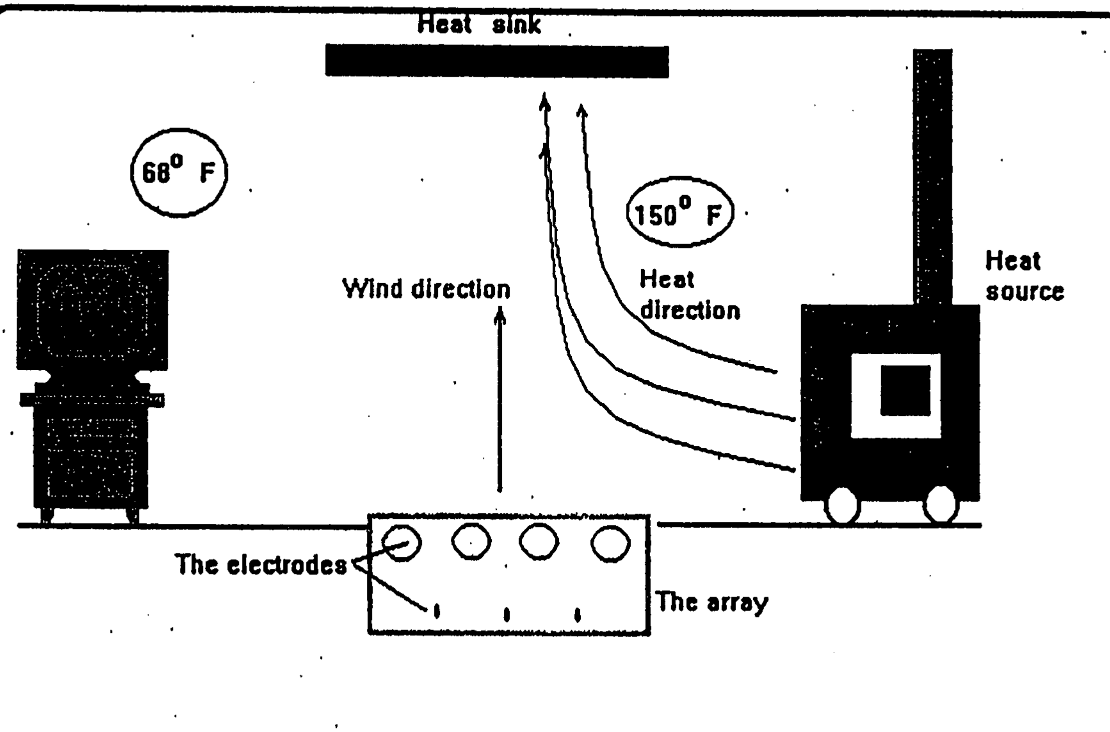


Figure 29

Electrostatic Wind Generator

60104573.101698

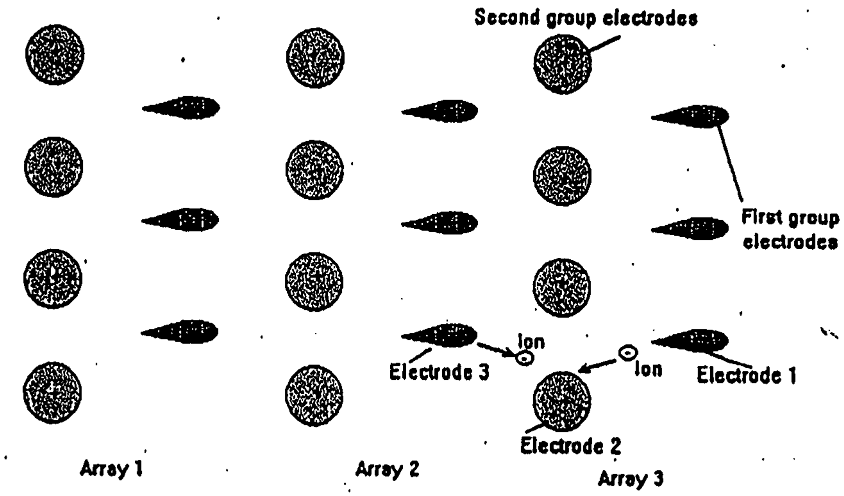


Figure 37

Electrostatic Wind Generator

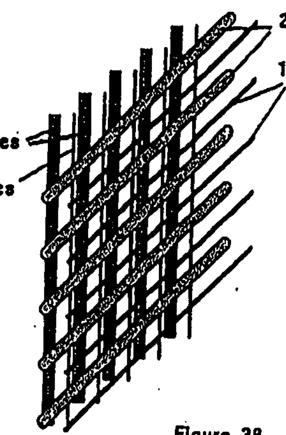
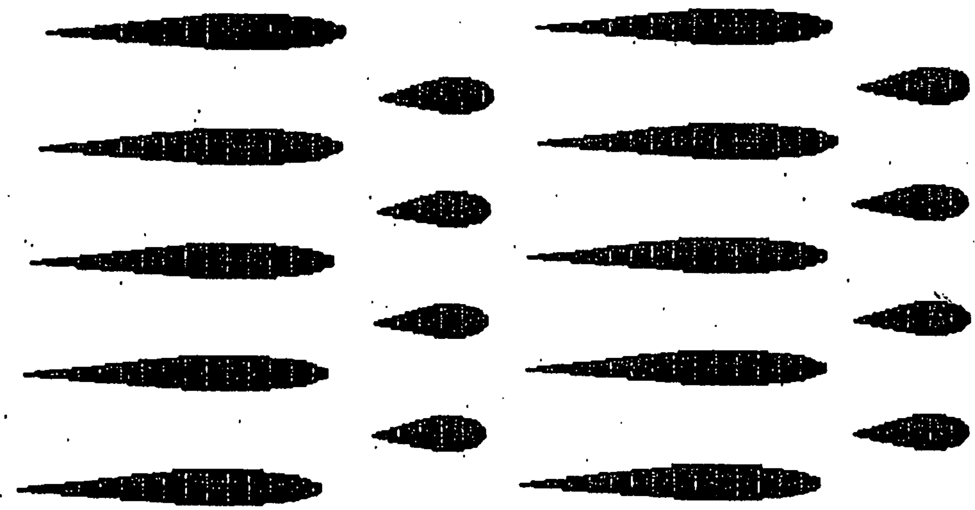


Figure 38

Electrostatic Wind Generator

60104573.101698



Electrostatic Wind Generator Figure 39

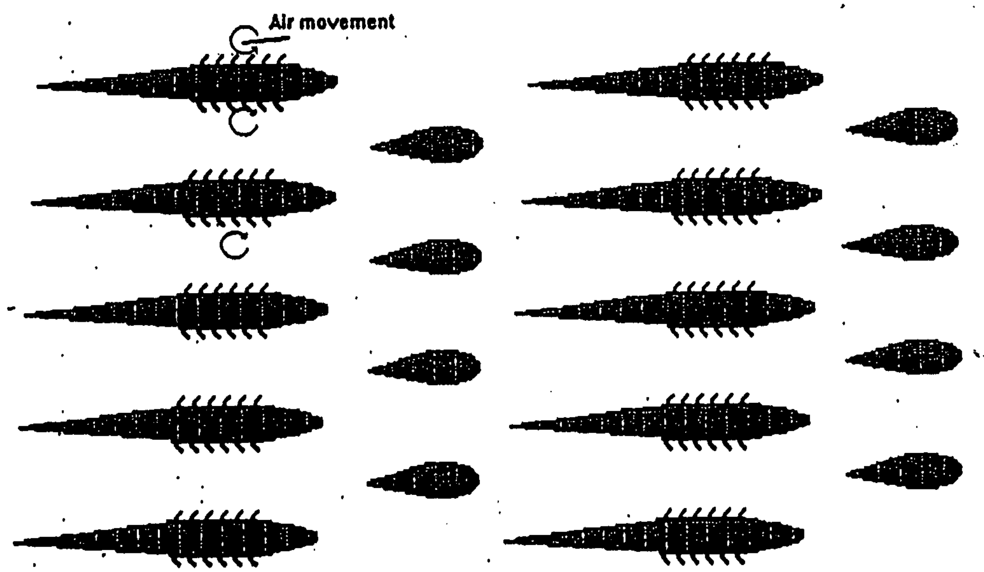


Figure 40

Electrostatic Wind Generator

60104573.101698

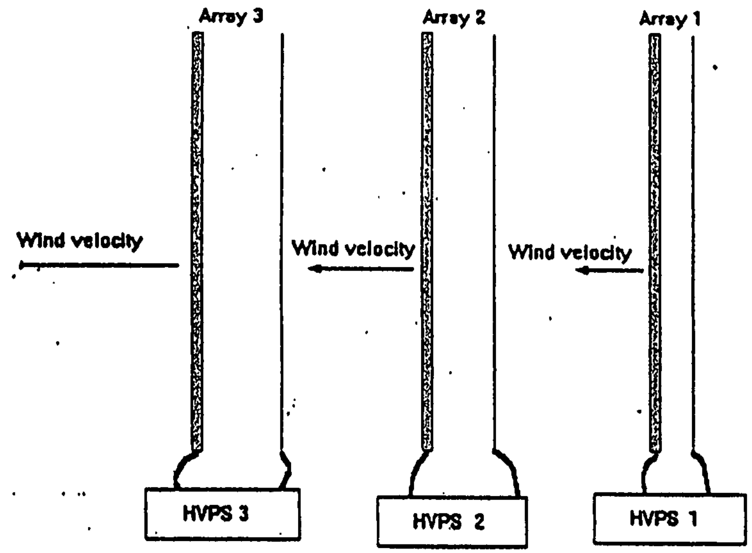


Figure 41

Electrostatic Wind Generator

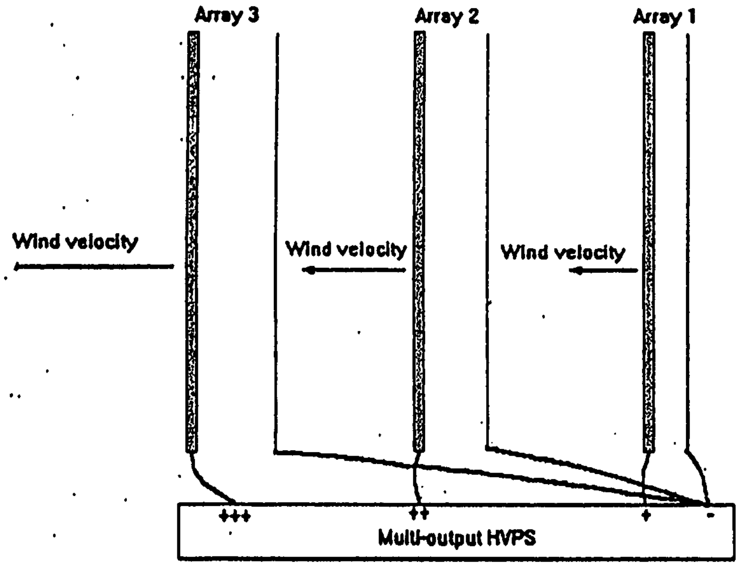


Figure 42

Electrostatic Wind Generator

60104573.101698

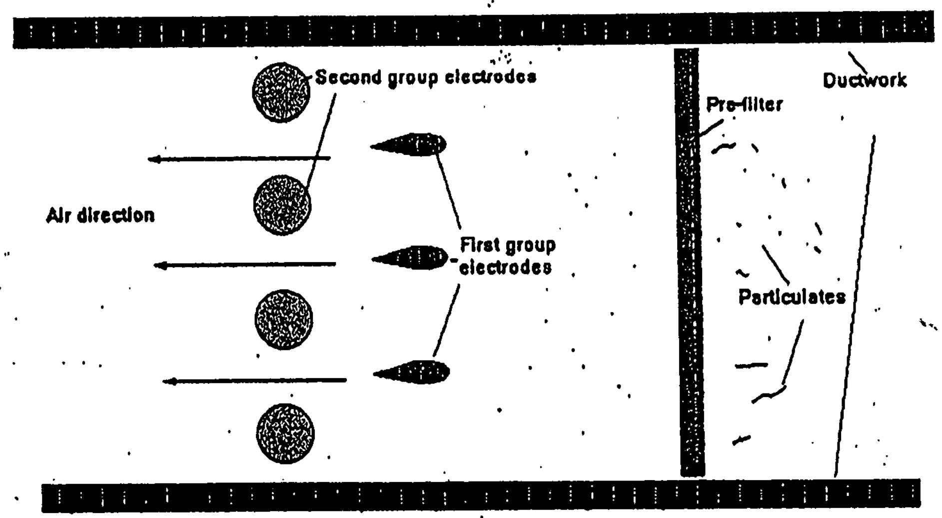


Figure 43

Electrostatic Wind Generator

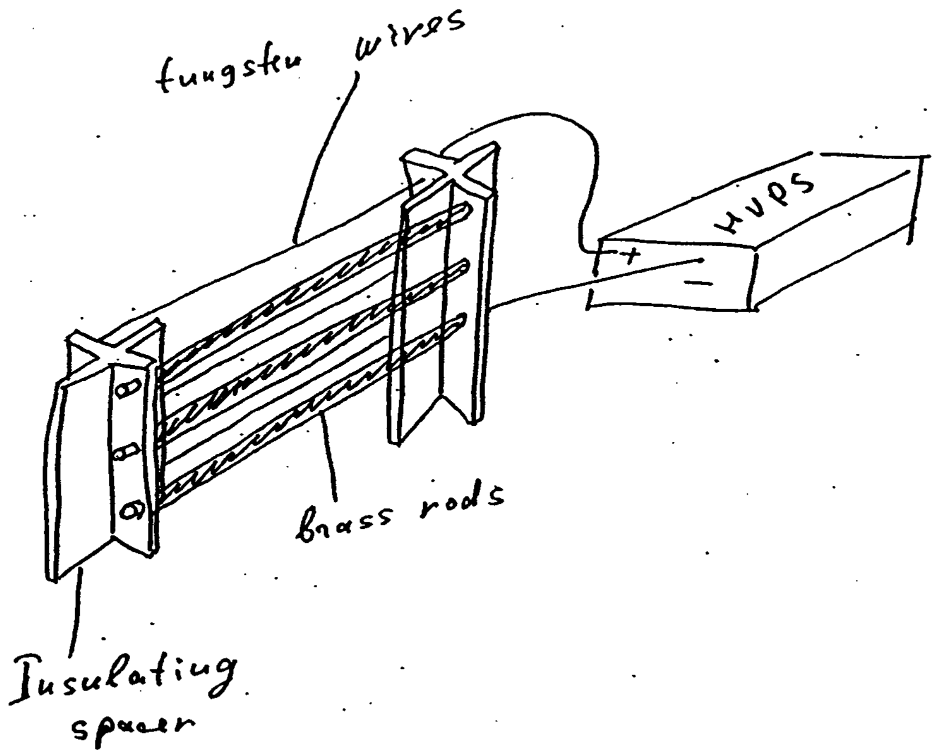


Figure 44

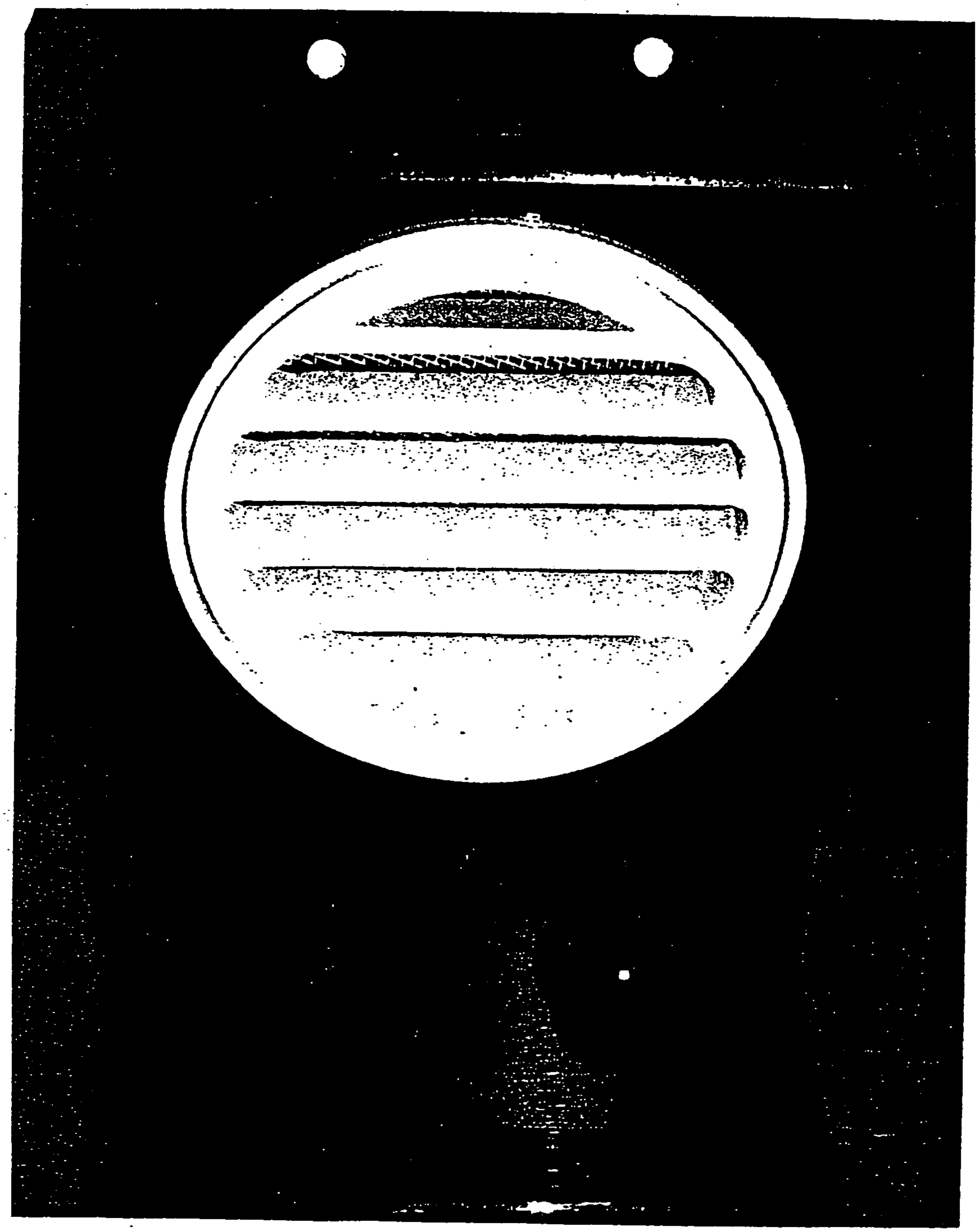
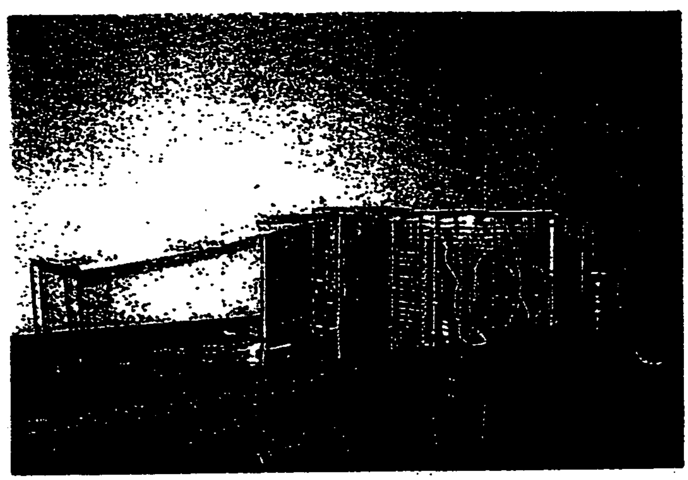


Figure 45

High Voltage Integrated

Introduces:



The Electron Wind Generator

Figure 46

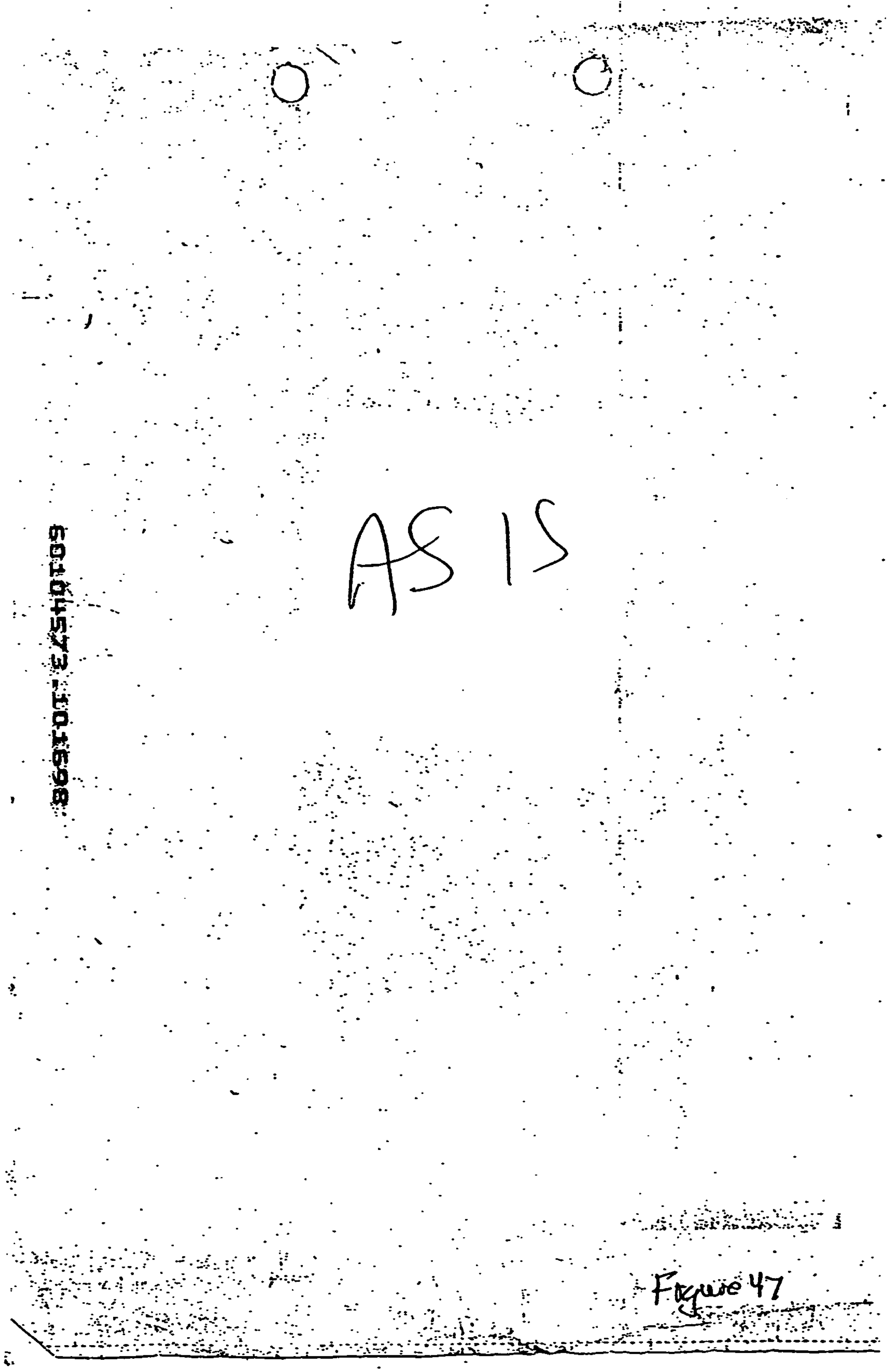


Figure 47

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
60/104,573 PROVISIONAL	10/16/98		0000	

APPLICANT

ROBERT L. FUHRIMAN JR., BELLEVUE, WA; IGOR KRICHTAFOVITCH, BOTHELL, WA.

CONTINUING DOMESTIC DATA*******************
VERIFIED

371 (NAT'L STAGE) DATA*******************
VERIFIED

FOREIGN APPLICATIONS**********
VERIFIED

FOREIGN FILING LICENSE GRANTED 11/18/98 ***** SMALL ENTITY *****

Foreign Priority claimed ☐yes ☐no 35 USC 119 (a-d) conditions met ☐yes ☐no ☐Met after Allowance Verified and Acknowledged Examiner's Initials ______ Initials	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
	WA	51		

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TITLE

ELECTRON WIND GENERATOR

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REQUEST FOR ACCESS TO AN APPLICATION UNDER 37 CFR 1.14(e)

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In re Application of	
Application Number 08/104573	Filed Oct 16, 1998
Art Unit	Examiner

Paper No. #2

Assistant Commissioner for Patents
Washington, DC 20231

1. ☐ I hereby request access under 37 CFR 1.14(e)(2) to the application file record of the above-identified ABANDONED Application, which is not within the file jacket of a pending Continued Prosecution Application (CPA) (37 CFR 1.53(d)) and is: (CHECK ONE)

☐ (A) referred to in:

United States Patent Application Publication No. 6584388, page _____, line _____,
United States Patent Number __________, column _____, line _____, or
an International Application which was filed on or after November 29, 2000 and which designates the United States, WIPO Pub. No. __________, page _____, line _____.

☐ (B) referred to in an application that is open to public inspection as set forth in 37 CFR 1.11(b) or 1.14(e)(2)(i), i.e., Application No. __________, paper No. _____, page _____, line _____.

2. ☐ I hereby request access under 37 CFR 1.14(e)(1) to an application in which the applicant has filed an authorization to lay open the complete application to the public.

Darlene Jones
Signature

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